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ALSO BY DR. BEAUMONT

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MEDICINE

Essentials for Practitioners and Students

By

G. E. BEAUMONT

*M.A., D.M.(Oxon.), F.R.C.P., D.P.H.(Lond.)
Hon. Consultant Physician to the Middlesex Hospital,
London; Consulting Physician to the Hospital for
Diseases of the Chest, Brompton, London; Formerly
Lecturer in Medicine, Middlesex Hospital, Medical
School; Censor, Royal College of Physicians, London;
Examiner in Medicine, University of Oxford.*

NINTH EDITION

With 71 Illustrations



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He is fortunate who perceives at a glance
 what it will do, and what it will not do,
 to omit.

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PREFACE TO THE NINTH EDITION

THE preparation of a new edition of this book has given me the opportunity of including a considerable amount of new material and of deleting sections which have become obsolete or of little value.

New articles have been written on the following subjects: Pneumatosis cystoides intestinalis, jaundice due to drugs or poisons, lupoid hepatitis, recurrent jaundice of pregnancy, respiratory function tests, chronic obstructive bronchitis, pneumocystic pneumonia, diffuse interstitial pulmonary fibrosis, cardiac resuscitation, extracranial arterial lesions, the subclavian steal syndrome, the carpal-tunnel syndrome, chronic pyelonephritis, the artificial kidney, polymyositis, polymyalgia rheumatica, autoimmune diseases, pre-diabetes, galactosæmia, congenital thyrotoxicosis, the uses of œstrogens, and oral contraceptives.

The following sections have been largely rewritten: The treatment of peptic ulcer, visceroptosis, the treatment of chronic bronchitis, asthma and pulmonary tuberculosis. Emphysema. The treatment of atrial fibrillation, heart block and the failing heart. Takayasu's arteriopathy, encephalitis, the diagnosis of pernicious anæmia, the megaloblastic anæmias, scarlet fever, diphtheria, the treatment of tetanus and rheumatic fever. Rickets, scurvy, beri-beri, pellagra, the adrenogenital syndrome and Cushing's syndrome.

Notes have been added on the following subjects: The gastro-camera, gastric cooling, the Peutz-Jegher's syndrome, active juvenile cirrhosis, monamine-oxidase inhibitors, cuffed tracheostomy, Goodpasture's syndrome, pulmonary alveolar microlithiasis, pigeon breeder's lung, Tietze's syndrome, alcoholic cardiac myopathy, hyperbaric oxygen, a decarboxylase inhibitor, spontaneous periodic œdema, cerebral atrophy, little strokes, vertebro-basilar insufficiency, acute pyelonephritis, peritoneal dialysis, macroglobulinæmia, measles live vaccine, canicola fever, ocular myopathy, the "brown bowel" syndrome, nonketoacidotic diabetic coma, hyperosmolar diabetic coma, pseudogout, Hartnup disease, adrenal cortical steroids, anterior and posterior pituitary hormones, thyrocalcitonin, sub-aqua diving and aflatoxin.

Other additions include the use of over 50 new preparations, and three new figures.

Dr. P. H. Friedlander has kindly revised his chapter on Water and Electrolytic Balance.

I wish to express my thanks to my publishers, Messrs. J. & A. Churchill for facilitating the production of this new Edition, and to Mr. A. S. Knightley for his ever-ready help.

My secretary, Miss E. G. Smyth, has again prepared the manuscript for the press and assisted in proof reading, and for her skilful help I am most grateful.

LONDON.

G. E. BEAUMONT.

PREFACE TO THE FIRST EDITION

It has been my endeavour to produce a text-book of medicine which is not too long for the use of the student preparing for his final examination and which will also be of assistance to the general practitioner. The ideal aimed at has been to include the essentials of medicine and to omit all extraneous matter, to give the student a clear account of the essential features of each disease described, and to supply the practitioner with information as to the investigations required to establish the diagnosis in any particular disease, together with an up-to-date account of a definite line of treatment.

Special attention is directed to clinical findings. Several detailed diet sheets are given, such as those suitable for the treatment of pneumonia, typhoid fever, diabetes, nephritis, gastric ulcer, obesity, constipation, etc. The appropriate dosage, prescriptions and methods of administration of drugs are included in the treatment sections of the various diseases, over one hundred prescriptions being given in full. No effort has been spared to bring every article up to date, to illustrate them with explanatory diagrams, figures and temperature charts, and to connect them with cross references. A series of diagrams, illustrating the anatomy and physiology of the parts concerned, has been introduced into the chapter dealing with nervous diseases, so that this difficult branch of medicine may be more easily understood. The old anatomical terminology has been employed, but a glossary showing the corresponding terms in the international (B.N.A.) nomenclature is included at the beginning of the book.

It is still the duty of the general physician, attached to the teaching staff of a general hospital, to care for patients suffering from most branches of medical diseases, and to instruct students in the symptoms, signs and treatment of such diseases. Such is the reply, if reply be needed, to the criticism that the day of the one-man text-book has passed. If this is so, it could be argued that no single physician should be allowed to teach general medicine and have charge of general medical wards.

Psychological and Dermatological medicine have not been included. They are highly specialised subjects, which are not dealt with in the general medical wards of a hospital. It is true that the student and practitioner must have a working knowledge of these branches of medicine, but this is best acquired from practical experience in the special departments of a general hospital. Infectious fevers have been included, as they frequently cause difficulty in the diagnosis of other medical diseases, and they are so important in general practice. Apart from this, the diseases described are those treated in the medical wards of a general hospital.

This book is largely based upon personal experience in hospital and private practice, and I am indebted first of all to my teachers, and secondly to the authors of the numerous books and articles which I have read. I should like to acknowledge them in detail, but space does not permit, and I take this opportunity of thanking them all for the information they have put before the medical profession.

It is a great pleasure to express my gratitude to Dr. Lee Lander, who has read the typescript and made valuable suggestions and alterations. The publishers of this volume have rendered me every facility and assistance: they have been patient during the five years it has taken me to write and rewrite the manuscript, and I cannot thank them sufficiently for their help and courtesy.

G. E. BEAUMONT.

LONDON, 1932.

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BLOOD

Normal Chemical Constituents

FIGURES are mg./100 ml. unless indicated otherwise. mEq./L = milli-equivalent per litre. This is one thousandth of a gramme equivalent, which is the amount of a compound which can react with, or be substituted for, one gramme of hydrogen. Conversion from mg./100 ml. is effected by the following formula : $\text{mEq./L} = \frac{10 \times \text{mg./100 ml.} \times \text{valency}}{\text{atomic weight}}$.

ESTIMATION	WHOLE BLOOD	PLASMA OR SERUM
Amylase	—	40-200 units/100 ml.
Alkali reserve (as HCO_3')	—	53-77 vol. $\text{CO}_2\%$ (24-25 mEq./L).
Amino-acid nitrogen	4-8	3-7
Bilirubin (Van den Bergh)	—	0.1-0.8
Calcium (total)	5-7	9-11 (4.5-5.5 mEq./L).
" (diffusible)	—	4.2-5.6 (2.1-2.8 mEq./L).
Chlorides (as Cl')	270-310 (76-87 mEq./L)	340-370 (96-105 mEq./L).
Cholesterol (total)	110-230	140-280
Creatine	2-8	0.2-0.8
Creatinine	0.5-2.5	0.5-2.5
Glucose (fasting)	60-110	60-110
Icterus index	—	1-6 units.
Iron	—	0.08-0.18
Non-protein nitrogen	25-30	20-40
Phosphatase (acid)	—	1-3 King-Armstrong units/100 ml.
Phosphatase (alkaline)	—	3-18 King-Armstrong units/100 ml.
Phosphate (inorganic, as P)	2.5-5	2-4.5
Potassium (as K')	150-250 (38-64 mEq./L)	17-22 (4.4-5.6 mEq./L).
Protein (total)	—	5.5-8 G./100 ml.
Albumin	—	3.5-6 G./100 ml.
Globulin	—	1.5-3 G./100 ml.
Fibrinogen	—	0.2-0.4 G./100 ml.
Prothrombin time	—	14-18 seconds
" concentration	—	70%-140%
Sodium (as Na')	170-225 (74-98 mEq./L)	320-345 (139-150 mEq./L)
Transaminase (S.G.O.T.)	—	4-40 units/ml.
Transaminase (S.G.P.T.)	—	5-35 units/ml.
(see p. 78)		
Urea	15-40	15-40
Uric acid	1-4	1-4
Vitamin A	—	0.02-0.05 (20-70 i.u./100 ml.)
Vitamin C	0.6-1.8	0.5-2.0

Approximate Equivalents

Weights

1 milligram (mg.)	=	1/65 grain (gr.)
1 gramme (G.)	=	15.4 grains (gr.)
1 gramme (G.)	=	1/28.5 ounce (oz.)
1 kilogram (kg.)	=	2.2 pounds (lb.)
1 kilogram (kg.)	=	1/6 stone (st.)
1 grain (gr.)	=	65 milligrams (mg.)
1 ounce (oz.)	=	8 drachms = 28.5 grammes (G.)
1 pound (lb.)	=	16 ounces = 456 grammes (G.)
1 stone (st.)	=	14 lbs. = 6.4 kilograms (kg.)

Measures

1 millilitre	=	16.6 minims (m.)
1 litre	=	35.2 fluid ounces (fl. oz.)
1 litre	=	1.76 pint
1 minim (m.)	=	0.06 millilitre (ml.)
1 fluid drachm (fl. dr.)	=	60 minims = 3.6 millilitres (ml.)
1 fluid ounce (fl. oz.)	=	8 fluid drachms = 23.4 millilitres (ml.)
1 pint	=	20 fluid ounces = 568 millilitres (ml.)

For practical purposes the following conversion equivalents may be used:—

1 gr.	=	60 mg.
1 oz.	=	30 G.
60 m.	=	4 ml.
1 fl. oz.	=	30 ml.
1 pint	=	600 ml.

CHAPTER I

THE ALIMENTARY SYSTEM

Introductory. Special investigations are required in the elucidation of many of the diseases of the alimentary system. These include test meals, opaque meals and enemata, gastroscopy, gastrophotography, tests for pancreatic and hepatic efficiency, cholecystography, and bacteriological and chemical examination of the feces.

THE MOUTH AND PHARYNX

Gingivitis

Definition. Inflammation of the gums. There are three varieties: Marginal, general and ulcerative. These will be considered separately.

Marginal Gingivitis

Etiology. Marginal gingivitis is associated with mouth-breathing, lack of efficient mastication and cleanliness of the gums, and the use of hard tooth brushes and tooth picks.

Clinical Findings. The patient may complain of bleeding or soreness of the gums on brushing the teeth. The gums are red and swollen at their margins, or they may be retracted around the teeth. Pus may be squeezed from between the gums and teeth.

Treatment. The causes of mouth-breathing should be eradicated if possible. Tartar should be removed from the teeth, and the gums massaged with the fingers towards the teeth, night and morning. The tooth brush should be small and soft, and no gritty powder used. A mouth-wash of milk of magnesia should be used at night.

General Gingivitis

Etiology. General gingivitis may be caused by drugs such as mercury or lead, or result from ill-fitting dentures and inattention to the teeth. It may also occur during pregnancy, in scurvy, or in association with any severe illness.

Clinical Findings. The gums are red, swollen, sore and bleed on pressure. A blue line may be seen in lead poisoning.

Treatment. This is as for marginal gingivitis. In scorbutic or pre-scorbutic conditions, as judged by urine tests, vitamin C should be given until the patient is saturated. The initial dose is ascorbic acid tab. 50 mg., 2 t.i.d. followed after a few days by 50 mg. b.i.d.

Ulcerative Gingivitis

Etiology. Ulcerative gingivitis is associated with the *B. fusiformis* and the *Treponema vincenti*. Pyogenic organisms may also be present.

Clinical Findings. There is an acute infection, often with pyrexia.

The gums are painful and swollen. Sloughing may occur and the teeth fall out. The infection may spread to the tonsils or pharynx.

Treatment. A mouth-wash such as gargarisma pot. chlorat. should be used frequently. Good results have been obtained in some cases by the oral administration of nicotinic acid tab. 50 mg. 1 five times daily for 10 days, or by the oral administration of metronidazole (Flagyl), 200 mg. tab., t.d.s. for 7 days. A penicillin lozenge may be placed between the affected area of the gum and the cheek, and allowed to dissolve, every hour for 8 doses, or the gum may be sprayed with a penicillin solution (1,000 units per ml.) every 2 hours. In severe cases the best result is obtained by the intramuscular injection of 800,000 units of a procaine penicillin every morning and evening for 5 days.

Pyorrhœa Alveolaris

This may be a more advanced stage of marginal gingivitis, or occur independently. There is inflammation of the periodontal membrane around the tooth root, and, later, rarefying osteitis of the alveolar margin. No specific causative organism has been found, but streptococci and various anaerobes are usually present. Pyorrhœa should be adequately treated by a dental surgeon, but wholesale extractions for marginal gingivitis are to be deprecated.

Dental Abscesses

The Alveolar Abscess. This may result either from dental caries leading to inflammation and death of the pulp of the tooth, or from periodontitis. The abscess is painful.

The Small Apical Abscess. This is usually due to infection of the pulp in a crowned or carious tooth. There is no actual pus present, but a small granulomatous mass, which often causes no local symptoms, is revealed by X-ray examination. The focal infection is considered to be etiologically connected with numerous diseases, such as rheumatism, thrombo-phlebitis migrans, bacterial endocarditis, unexplained pyrexia, etc.

The offending tooth should be extracted.

Halitosis

Definition. Offensive breath.

Etiology. Halitosis may be due to numerous causes, such as chronic tonsillitis, pyorrhœa, infection of the antra or adenoids, chronic gastritis, bronchiectasis, etc.

Stomatitis

Definition. Inflammation of the mucous membrane lining the mouth. Six varieties are described.

Catarrhal (Simple) Stomatitis

Etiology. Catarrhal stomatitis may be due to local causes, such as a sharp tooth, very hot food, or over-smoking. It may also result from

drugs, such as mercury, iodides, bismuth or arsenic, and it is also found in prolonged fevers and in cachectic conditions.

Clinical Findings. The patient complains of salivation, a bad taste and a sensation of heat in the mouth.

Treatment. The cause should be removed if possible, and a mouth-wash of pot. permang. 1 in 8,000 in water used frequently.

Aphthous Stomatitis

Etiology. Aphthous stomatitis may be associated with debility, nervous tension, or gastro-intestinal disturbances. The cause is unknown.

Clinical Findings. The patient is usually a woman. There is pain in the mouth, chiefly on mastication. Small round or oval red areas are seen which rapidly ulcerate. They vary in size from a pin's head to a split pea, and usually occur inside the cheek, under the tongue, or on the gums. They frequently recur.

Treatment. The ulcers should be touched with hydrogen peroxide diluted with 5 parts of warm water. A carbenoxolone (Biogastrone) lozenge, 5 mg., may be sucked 4 times a day.

Ulcerative Stomatitis

Etiology. Ulcerative stomatitis may be due to blood diseases such as acute leukæmia and agranulocytosis or to infection with Vincent's organisms. In the latter case the ulceration is usually associated with debilitating diseases, such as dysentery and scurvy in adults, and measles and diphtheria in children.

Clinical Findings. The condition is the same as that described on p. 1; the cheeks, tongue and other parts of the mouth may be involved.

Treatment. This depends upon the cause and is described under the headings acute leukæmia, agranulocytosis and ulcerative gingivitis.

Parasitic Stomatitis

(Thrush)

Etiology. Thrush is caused by the fungus *Candida albicans*.

Clinical Findings. The patient is usually an infant, or an adult who is very debilitated from diseases such as dysentery, tuberculosis, typhoid fever or cancer. Whitish patches occur on the gums, cheeks and tongue, and may spread to the pharynx, nose, larynx, œsophagus and stomach.

Treatment. Feeding-bottles should be kept scrupulously clean and "comforters" forbidden. A 1% aqueous solution of gentian violet may be applied on gauze t.i.d. for 3 or 4 days, or Nystatin oral suspension, 1 ml., dropped into the mouth 4 times daily. Treatment in adults is mainly that necessary for the debilitating condition.

Gangrenous Stomatitis

(Cancrum Oris. Noma)

Etiology. The treponeme and fusiform bacillus of Vincent are usually present.

Clinical Findings. The patient is usually a child who is very debilitated owing to acute leukæmia, neutropenia or to measles. Pain is noticed in the mouth, and an ulcer is seen on the inner side of the cheek which may rapidly spread and perforate the cheek. There is œdema of the face, and the gums or jaw may be similarly affected. The temperature is usually high, and death frequently follows from toxæmia or bronchopneumonia.

Treatment. A course of three-hourly intramuscular injections of benzylpenicillin should be given, using 5,000 units (8 mg.) for every year of the child's age.

Vesicular Stomatitis

Etiology. This may be a manifestation of herpes, when it is known as herpetic stomatitis or herpes buccalis. The herpetic eruption may be limited to half of the hard palate or involve the tongue, gums and cheek on one or both sides. There is malaise, and pain both inside and outside the mouth, especially on mastication. The vesicles are situated on an inflamed base of mucous membrane.

In foot and mouth disease, which rarely affects man, vesicular stomatitis (epizootic stomatitis) may occur.

Treatment. A mouth-wash of glycerin. thymol. co. (B.P.C.), diluted with 5 parts of warm water, should be used.

The Stevens-Johnson Syndrome

(Erythema exudativum multiforme bullosum with conjunctivitis and stomatitis)

This syndrome is characterised by stomatitis, conjunctivitis, a bullous skin rash and fever. In some cases there is urethritis and balanitis. The cause is unknown, but it may follow the use of long acting sulphonamides such as sulphadimethoxine (Madribon). It is most commonly met with in males under the age of 20 years. Loss of vision may result from corneal ulceration or deeply seated ocular inflammation. The rash tends to have a peripheral distribution and may be mistaken for small-pox.

Treatment. Procaine penicillin, 800,000 units, should be injected intramuscularly morning and evening, and tab. sulphamerazine 0.5 G., 2 tabs. given by mouth every 4 hours for 7 to 10 days. One per cent hydrocortisone eye drops, 2 drops in each eye every 2 hours, may be helpful, together with intramuscular injections of 25 i.u. ACTH (adrenocorticotrophin) every 6 hours for 4 or 5 days, the dose being then tapered off during the next week.

Behçet's Syndrome

This appears to be allied to the Stevens-Johnson syndrome. It is characterised by recurrent genital and oral ulceration, with lesions of the anterior chamber of the eye. It occurs chiefly in the Eastern Mediterranean area. The eyes may be sore and painful and eventually blindness may ensue. There is a tendency for spontaneous recovery and relapses. In some instances the central nervous system is involved,

with headache, vertigo and diplopia. Skin lesions, arthritis, thrombophlebitis and cellulitis may also occur. Antibiotics are of no avail. In one of my cases a favourable result occurred after protein shock therapy, 100 millions of T.A.B. organisms being injected intravenously. Prednisone or adrenocorticotrophin may be tried, the former in doses of 5 mg. t.i.d. by mouth, the latter 25 i.u. as for the Stevens-Johnson syndrome.

Ludwig's Angina

This is an acute infection of the floor of the mouth due to the streptococcus. There is a hard brawny swelling under the jaw and in the neck, and the patient is very ill. Treatment consists in free and deep incisions and the intramuscular injection of benzylpenicillin, 500,000 (300 mg.) units six hourly.

Tonsillitis

Definition. Inflammation of the tonsils.

The following varieties are described:—Acute, including acute follicular tonsillitis and Vincent's angina. Chronic tonsillitis.

Acute Follicular Tonsillitis

Etiology. There is infection of the tonsils with pyogenic organisms, usually streptococci. The condition may be primary, or develop in association with such diseases as rheumatic fever, acute nephritis, scarlet fever or secondary syphilis.

Pathology. The tonsils are swollen and an exudate collects in the follicles.

Clinical Findings. The patient is often a child or young adult who complains of malaise, with pain in the throat made worse by swallowing.

On Examination: The temperature is usually raised to 101° F. (38.3° C) or more, the tonsils are red, enlarged, and yellowish-white spots may be seen on them, due to the exudation in the follicles. This exudation may coalesce and form a membrane, which, however, is usually limited to the tonsils and does not spread to the pharynx or uvula. The cervical lymph nodes are generally only slightly enlarged. A swab should be examined to exclude the presence of diphtheria bacilli or the organisms of Vincent's angina.

Differential Diagnosis. It is important to exclude diphtheria, Vincent's angina, the onset of scarlet fever and the presence of active syphilis.

Course and Complications. The disease usually lasts 7 to 10 days. Nephritis may occur as a complication, and the urine should always be tested for protein and blood. Infection may spread to the paranasal sinuses or middle ear, or the cervical lymph nodes may become chronically enlarged. Septicæmia and toxic myocarditis are rare but important complications. Recurrences are common, especially in the early or late winter.

Prognosis. This is usually good. Repeated attacks lead to small fibrosed and cryptic tonsils, which may become foci of infection for quinsy or other diseases, such as rheumatism, sciatica, or endocarditis. Death may occur from septicæmia or myocarditis.

Treatment. The patient should be put to bed, kept on a liquid or semi-solid diet, and the bowels opened with an aperient. **Local treatment:** Hot gargles of potassium permanganate (1 in 8,000) should be used frequently, if possible. If the patient cannot gargle, the throat may be sprayed with a hot alkaline lotion such as Sod. bicarb., sod. benzoat., sod. chlorid. āā 10 gr. (0.6 G.), aq. ad 1 fl. oz. (30 ml.); $\frac{1}{2}$ fl. oz. (15 ml.) to be used in 6 fl. oz. (180 ml.) of warm water occasionally. The majority of cases of acute tonsillitis can be rapidly cured by the intramuscular injection of 300,000 units of a procaine penicillin morning and evening for 4 or 5 days. If recurrences are frequent tonsillectomy is usually advisable.

Vincent's Angina

Etiology. Ulceration of the tonsil, due to infection with the *B. fusiformis* and the *Treponema vincenti*.

Clinical Findings. The patient complains of symptoms resembling those of subacute tonsillitis. There is not usually severe pain and the temperature is normal or slightly raised. In some cases the patient is severely ill with high fever and muscle and joint pains.

On Examination: A yellowish-white membrane or ulcer may be seen on or behind one tonsil. A swab should be examined for the presence of diphtheria bacilli and Vincent's organisms.

Differential Diagnosis. Acute tonsillitis, diphtheria, rheumatic fever, syphilis and agranulocytic angina must be excluded.

Course. This is benign, the condition usually clearing up spontaneously in about a week, but some cases prove more intractable.

Treatment. The throat should be sprayed every 2 hours with a penicillin solution containing 1,000 units per ml., and a course of intramuscular injections of 300,000 units of a procaine penicillin given morning and evening for 5 to 7 days.

Chronic Tonsillitis

Etiology. Chronic tonsillitis may result from acute tonsillitis or develop insidiously.

Clinical Findings. The patient is usually a child or young adult who gives a history of repeated attacks of sore throat, generally in the winter.

On Examination: The tonsils usually look "unhealthy," being sometimes large and almost meeting in the mid-line, or else of normal size but showing depressions or pits, or small and scarred. Pus or a cheesy exudate, of very offensive odour, may in some cases be squeezed out from the tonsils. The adenoid tissue at the back of the nose may be hypertrophied. The lymph nodes in the neck may be enlarged, especially below the angle of the jaw. If there is marked

obstruction to respiration and the patient is a mouth-breather, he shows the characteristic appearances ; thus the lips are dry and cracked, the central teeth prominent, the gums are dry, and marginal gingivitis may be present. Further, the palate is often narrow with a high arch, and the nose is thin with feebly developed alar nasal cartilages. The chest may be pigeon-breasted. There is often some deafness, restlessness at night, and the child is backward at school.

Course and Complications. The patient is liable to colds, sore throats, otitis media, bronchitis and general ill-health. Local or systemic infections, such as diphtheria, scarlet fever, rheumatism, etc., may occur in association with chronic tonsillar sepsis.

Prognosis. This is favourable, as the disease can be eradicated surgically.

Treatment. In the majority of cases the tonsils and adenoids should be removed by operation. Medical treatment consists in the use of a throat paint such as the *Pigmentum Mandi*, Iodin. 6 gr. (0.86 G.), pot. iod. 20 gr. (1.2 G.), ol. menth. pip. 5 m. (0.3 ml.), glycerin. ad 1 fl. oz. (30 ml.), or the administration of penicillin as lozenges and by injection as described above for acute tonsillitis.

The Lingual Tonsil. This is situated at the base of the tongue, and when enlarged may cause a persistent, irritating cough, curable by operation.

Quinsy

(*Peritonsillar Suppuration. Peritonsillitis*)

Definition. Abscess formation in the connective tissue around the tonsil.

Etiology. Quinsy is generally secondary to chronic tonsillitis.

Clinical Findings. The patient, who is usually a young adult, feels ill with shooting pains in the ear and throat, rigors, often intense dysphagia and inability to open the mouth fully.

On Examination : The breath is offensive and the mouth is kept slightly open. A swelling due to the abscess is seen usually above and on the outer side of one or other tonsil. This pushes the tonsil out of view and the uvula is deviated from the mid-line.

Differential Diagnosis. A sarcoma of the tonsil may be mistaken for quinsy, with the former there is usually no fever.

Course and Complications. The abscess points in a few days, and usually bursts through the anterior pillar of the fauces, with immediate relief of pain. Complications are rare. They include suppuration in the neck, pyæmia, hæmorrhage, œdema of the glottis, thrombosis of the internal jugular vein, or even asphyxia from inhalation of the pus if the abscess ruptures during sleep. Blockage of a few bronchi by inhaled pus will lead to collapse of a portion of the lung, and hæmoptysis may result from the inflamed bronchial mucous membrane.

Treatment. In the early stages the treatment is as for acute follicular tonsillitis. The attack is best terminated surgically by incision, as soon as pus has formed, and the tonsils should be removed later.

Tuberculosis of the Tonsils

Pathology. The tonsil may very rarely be affected clinically apart from pulmonary tuberculosis. The patient complains of a chronic sore throat and generally of symptoms of pulmonary tuberculosis, such as cough, expectoration, malaise, etc.

On Examination: The tonsil may be ulcerated. In the majority of cases there is definite pulmonary and laryngeal tuberculosis and tubercle bacilli are present in the sputum. In another group of cases the clinical features are those of inflammation of cervical lymph nodes, the tubercle bacilli gaining entrance through the tonsils and settling in the lymph nodes in the neck. In such cases tubercles may or may not be present macroscopically in the tonsils, but tonsillectomy is usually advisable. In all cases a course of streptomycin, para-aminosalicylic acid and/or isoniazid should be given (see p. 170).

Syphilis of the Tonsils

The tonsil may be infected in the primary stage, when the lesion present is a chancre. In secondary syphilis a sore throat with acute tonsillitis or the formation of superficial plaques (snail-track ulceration) on the tonsils may occur. In tertiary syphilis ulceration due to a gumma may be noted.

Tumours of the Tonsil

These are nearly always malignant, being either epitheliomatous or sarcomatous (lymphosarcoma or round-celled sarcoma). In epithelioma there is usually ulceration of the tonsil and hard enlarged lymph nodes in the neck. In lymphosarcoma the tonsil appears swollen, pale and waxy, or may be ulcerated. It grows rapidly, and neighbouring lymph nodes are usually soon enlarged.

The Tongue

An examination of the tongue does not give so much information concerning the health of the patient as was at one time believed. Thus, the tongue may be almost black (melanoglossia) apart from taking drugs, and yet the patient be in good health, or with a tongue clean and moist the patient may be suffering from a mortal illness such as cancer.

Furred tongue. A white or brown coat may result from a milk diet or from drugs such as bismuth or iron, or it may be associated with fevers, chronic alcoholism, gastro-intestinal disorders, or local causes such as carious teeth or heavy smoking.

A soft flabby tongue with impressions of the teeth on its edges may occur in atonic dyspepsia and gastric hyposecretion.

A red firm tongue may be associated with gastric hypersecretion or with diabetes mellitus (raw beef tongue).

A fissured tongue (scrotal tongue) occurs usually as a congenital condition, and is of no pathological significance. In tertiary syphilis the tongue may be fissured.

A white strawberry tongue occurs in scarlet fever. The papillæ are covered with a white fur.

A red strawberry or raspberry tongue occurs in a later stage of scarlet fever. The tongue has peeled and the bright red papillæ stand out.

A dry glazed or brown tongue occurs in the terminal stages of severe illnesses, such as cholera, dysentery and septicæmia.

A slaty-blue tongue may be seen in Addison's disease.

A black tongue (melanoglossia). The black tongue is usually hairy due to overgrowth of filiform papillæ on the centre of the dorsal surface. The colour is usually thought to be due to a fungus, the *Aspergillus niger*, whose spores are black. In other cases yeasts, or bacteria producing black colonies, have been isolated, but the black colour may be due to food debris, or the papillæ may darken with age. Other causes which have been suggested include chronic naso-pharyngeal infection, tobacco smoke, irritant mouth-washes, sulphonamide drugs, penicillin, chloramphenicol, chlortetracycline (Aureomycin) and oxy-tetracycline (Terramycin), gastric hypersecretion and a trophoneurosis. It is not due to nicotinic acid deficiency, which causes black tongue in dogs. It usually causes no ill effects, and may disappear spontaneously, treatment being not likely to prove efficacious. The tongue should be scraped daily with an inverted spoon, and attention paid to oral and dental hygiene. The patient should not smoke. The application of a 1 in 1,000 solution of thymol has been recommended for fungus infections.

A sore tongue may occur in ulceration from any cause, in the early stages of pernicious anæmia, in sprue or in mercurial poisoning.

A smooth glazed tongue may be seen in pernicious or simple achlor-hydric anæmia.

Enlarged tongue. Macroglossia may be met with in primary amyloidosis, myxœdema with cretinism, acromegaly, angio-neurotic œdema or be due to hæmorrhage in hæmophilia.

Glossitis

Definition. Inflammation of the tongue. There are two varieties, acute and chronic glossitis.

Acute Glossitis

Etiology. Acute glossitis may result from abrasions of the tongue associated with dental caries, or from insect bites or burns. Occasionally acute glossitis complicates severe fevers or small-pox, or results from sucking penicillin lozenges. The infection is usually streptococcal.

Clinical Findings. The patient complains of pain and swelling of the tongue and the pain may radiate to the ears. There is usually marked prostration and high fever.

On Examination: The tongue is red and swollen, and enlarged lymph nodes may be felt in the neck.

Course and Complications. The disease is usually rapidly progressive. Abscesses or gangrene may occur in the tongue, and complications include œdema of the larynx, Ludwig's angina and septicæmia.

Prognosis. This is very unfavourable, the majority of cases proving fatal.

Treatment. Cold applications such as ice should be placed on the tongue. Unless the glossitis is due to penicillin lozenges, penicillin should be administered by injection as described above for acute tonsillitis.

Chronic Glossitis

Etiology. Chronic glossitis may result from irritation due to smoking, from syphilis, chronic alcoholism, or occur in association with oral sepsis, anaemia and achlorhydria. A raw, glazed and superficially fissured tongue, often associated with cracked leukoplakic angles of the mouth (angular stomatitis) may be met with in pellagra, tropical sprue, pernicious anaemia, the nutritional anaemias and idiopathic steatorrhœa. It is thought to be due to deficiency of the vitamin B complex.

Clinical Findings. The patient complains of a sore tongue, and in severe cases the pain may keep him awake.

On Examination: Red smooth patches may be seen on the tongue.

Course and Complications. The condition is usually of long duration, and leukoplakia may develop.

Prognosis. This is usually good if adequate treatment is begun early.

Treatment. All irritating food should be avoided; smoking and alcohol must be forbidden. Any septic focus in the mouth or a sharp tooth should be treated. Tincture of hamamelis 60 m. (4 ml.) in water 1 fl. oz. (30 ml.) may be applied to the tongue night and morning. Nicotinic acid tab. 50 mg., 1 or 2 t.i.d. should be given by mouth for the glossitis due to vitamin B₂ deficiency and for the angular stomatitis riboflavin tab. 10 mg. t.d.s.

Leukoplakia Buccalis

Definition. A condition of keratosis of the tongue or mucous membrane of the mouth with thickening of the deeper tissues.

Etiology. Leukoplakia is usually associated with syphilis, over-smoking, chronic alcoholism and oral sepsis.

Clinical Findings. The patient is commonly a male over the age of 40. There are usually no symptoms, but thickened whitish-grey patches occur on the tongue, and at times on the cheeks or gums.

Course and Complications. Ulceration or epitheliomatous changes are prone to occur.

Treatment. Owing to the risk of malignant disease, excision of the patches is usually recommended. Anti-syphilitic treatment is generally of no avail.

Geographical Tongue

(Eczema of the Tongue)

Etiology. The cause is unknown.

Clinical Findings. The patient may complain of itching or burning of the tongue.

On Examination: Whitish rings may be seen surrounding a red area of the tongue. The rings may spread and fuse with each other

forming outlines resembling a map. Fresh lesions begin as small whitish patches which shed their epithelium at the centre.

Course. The condition generally persists for some time.

Treatment. Irritants should be avoided and a simple mouth-wash of half a teaspoonful (2 G.) of sod. bicarb. in a glass of warm water used morning and evening.

Ulcers of the Tongue

These may be: 1. Simple, due usually to irritation of a tooth, or associated with ulcerative stomatitis. Sub-lingual ulcers may be met with in whooping-cough, in cretinism associated with a large tongue, or in ravenous breast-fed infants. 2. Granulomatous, caused by syphilis or tuberculosis. 3. Malignant, an epithelioma.

Tumours of the Tongue

These are simple or malignant. A papilloma may occur, sessile or pedunculated. Operative removal is always advisable. An epithelioma is usually found in men over the age of 40. It may develop from a papilloma or from a leukoplakic patch. There is a tendency to ulceration and secondary deposits are found in the cervical lymph nodes. Treatment is surgical, either by radium, diathermy or excision.

Granulomata of the Tongue

A gumma forms a firm slightly raised swelling, often seated near the centre of the tongue.

Tuberculosis causes painful ulceration, frequently near the tip, and is associated generally with pulmonary tuberculosis.

THE PHARYNX

Pharyngitis

Definition. Inflammation of the pharyngeal mucous membrane.

There are two varieties: Acute and chronic. Acute pharyngitis may be catarrhal or septic.

Acute Catarrhal Pharyngitis

(Sore Throat)

Etiology. Acute catarrhal pharyngitis may be due to a cold, to an adenoviral infection, or occur at the onset of specific fevers, such as measles or scarlet fever, or be caused by drugs, such as iodides or mercury. It is also sometimes seen in the secondary stage of syphilis or it may follow tonsillitis.

Clinical Findings. The patient complains of rawness at the back of the throat, with perhaps dysphagia.

On Examination: The pharynx is red and congested. General constitutional disturbance with slight pyrexia is usually present.

Course and Complications. A mild form of laryngitis may follow after the pharyngitis has disappeared.

Prognosis. This is usually good.

Treatment. Relief is obtained by a steam inhalation containing carbolic acid 5 m. (0.8 ml.) in one pint (600 ml.) of steaming water at 160° F. (71° C.), or by a gargle of sod. bicarb. 15 gr. (1 G.), aq. ad 10 fl. oz. (800 ml.)

Acute Septic Pharyngitis

Etiology. Acute septic pharyngitis is due to a streptococcal or a pneumococcal infection.

Clinical Findings. The pharynx is red, cedematous or sloughing, or a grey slimy exudate may form. The patient is very ill with a subnormal or a high temperature.

Complications. These include œdema of the larynx, Ludwig's angina, pneumonia, parotitis and septicæmia.

Prognosis. This is grave.

Treatment. Steam inhalations and hot fomentations may be used. The throat may be sprayed with a penicillin solution containing 1,000 units per ml., and a course of 600,000 units of a procaine penicillin given intramuscularly every 12 hours for 5 to 7 days.

Chronic Pharyngitis

There are three varieties of chronic pharyngitis: Simple or catarrhal (relaxed throat), granular or hypertrophic, atrophic (*pharyngitis sicca*).

Simple or Catarrhal Pharyngitis

Simple pharyngitis is due to over-smoking, chronic alcoholism, dust, or oral sepsis.

Clinical Findings. The patient is usually an adult male who complains of rawness, a tickling or pricking sensation in the throat, or of an ineffective paroxysmal cough. The voice may be hoarse.

On Examination: The pharyngeal mucous membrane appears congested and the venules may be dilated.

Granular Pharyngitis

Granular pharyngitis is also known as Clergyman's sore throat, and may occur in association with catarrhal infections or some weakness of the voice, and in children in association with adenoids.

Clinical Findings. The symptoms are much the same as those of simple pharyngitis.

On Examination: Small gelatinous-looking swellings (lymphoid nodules) are seen on the pharyngeal wall.

Atrophic Pharyngitis

This is associated with *rhinitis sicca*.

Clinical Findings. The symptoms resemble those of simple or granular pharyngitis.

On Examination: The pharynx is red and shiny, and muco-pus may be seen running down from the posterior nares.

Treatment. In all forms of chronic pharyngitis, irritants such as tobacco and alcohol should be avoided. A throat paint of Liq. ferri perchlor. 60 m. (4 ml.), glycerin. ad 1 fl. oz. (80 ml.), or Mandl's paint

(see p. 7), should be applied night and morning. Septic foci in the mouth and nose should be treated; speakers should rest the voice and, if necessary, take lessons in voice production.

Retropharyngeal Abscess

Definition. Suppuration in the submucous connective tissue behind the posterior pharyngeal wall. The prevertebral lymph nodes are first affected.

There are two varieties: Acute and chronic.

Acute Retropharyngeal Abscess

Etiology. Acute retropharyngeal abscess may occur in association with suppuration in the nose or posterior pharyngeal lymph nodes, septic tonsillitis, otitis media, or as a complication of scarlet fever, diphtheria and measles.

Clinical Findings. The patient is usually an infant, who has pain in the throat, and difficulty in swallowing or breathing. The cry may be quacking in character (*cri de canard*) and croup sometimes occurs.

On Examination: The child appears ill and is feverish. A bulging of the posterior pharyngeal wall can be seen, usually not quite central. It may be possible to feel fluctuation.

Course. Death may occur from rupture of the abscess and suffocation.

Treatment. This is surgical. An incision should be made through the mouth into the posterior pharyngeal wall without an anæsthetic, the child's head being lowered, so that the pus is not inhaled.

Chronic Retropharyngeal Abscess

Etiology. The condition is usually tuberculous, secondary either to tuberculous cervical or retropharyngeal lymph nodes, or to caries of the upper cervical vertebræ.

Clinical Findings. The patient is usually a child, and is commonly afebrile. There may be dyspnoea or snoring, but often there is no pain. Enlarged tuberculous lymph nodes or signs of cervical caries may be evident, and bulging may be seen in the posterior pharyngeal wall.

Treatment. This is surgical. The abscess should be opened externally in the neck.

Pharyngeal Ulcers

These may be: 1. Follicular. 2. Syphilitic: In primary syphilis a chancre may be seen, in secondary syphilis there are mucous plaques or pharyngitis, and in the tertiary stage ulcers or gummata may occur. 3. Tuberculous: Lupus may spread from the nose to the mouth, palate and pharynx; it shows a typical apple-jelly appearance. In advanced pulmonary tuberculosis there may be very painful ulcers in the pharynx. 4. Accompanying fevers, such as typhoid. 5. Epitheliomatous. 6. Diphtheritic.

Enlargement of the Uvula

The uvula may be enlarged in patients suffering from pharyngitis, relaxed throat, nephritis with œdema, or anæmia (œdematous). It may give rise to a cough.

Tumours of the Pharynx

These may be simple, such as a papilloma or angioma, or malignant such as an epithelioma or sarcoma. Malignant tumours are rare.

Pharyngeal Neuroses

1. *Globus Hystericus*. This is a motor spasm. The patient complains of a lump in the throat. The lingual tonsil may be enlarged.

2. *Anæsthesia*. This occurs especially in hysteria.

3. *Paræsthesia*. The patient complains of a feeling of suffocation and tickling in the throat.

Diverticula of the pharynx are considered later

THE SALIVARY GLANDS

Ptyalism

(Salivation)

Definition. Over-secretion of the salivary glands.

Etiology. The most important causes are: 1. *Drugs*, especially mercury, iodides, arsenic and pilocarpine. 2. *Reflex*: Oral, such as dental caries, stomatitis, and dentition. Esophageal, as with a growth. Gastric, at the onset of vomiting, gastric ulcer, etc. Hepatic and pancreatic inflammatory lesions. 3. *Nervous lesions* as in tabetic crises, *tic douloureux*, encephalitis lethargica and paralysis agitans. 4. *Dysphagia* due to mechanical causes as in fractured jaw, mumps, etc., or due to neuro-muscular causes as in bulbar paralysis, bilateral facial paralysis, myasthenia gravis and hydrophobia. In cases associated with dysphagia the saliva dribbles away and the secretion may not be excessive. Ptyalorrhœa is a functional condition, which may complicate pregnancy or occur in association with a high blood pressure.

Treatment. In each case this is directed to the underlying cause, but atropine and bromides may be given. Atropin. sulph. 1/200 gr. (0.3 mg.), aq. ad 60 m. (4 ml.), t.d.s. a.c.; or Pot. brom. 10 gr. (0.6 G.), aq. chlorof. ad ½ fl. oz. (15 ml.). ½ fl. oz. (15 ml.) t.d.s. p.c. X-ray treatment to the salivary glands may be required in obstinate cases. The dose should be small, sufficient to stop secretion from the salivary glands for about 2 months, but not sufficient to cause permanent damage.

Xerostomia

(Aptyalism)

Definition. Dryness of the mouth.

Etiology. Xerostomia may be due to: *Drugs*, especially belladonna and opium. *Fevers*. *Deficient fluid intake*. *Emotions* such as fear. *Local causes* such as thrush or chronic inflammation of the salivary glands as in Mikulicz's disease or in Sjögren's disease. *Old age*, especially

in women. In association with excessive loss of body fluids as in cholera and diabetes.

Treatment. Local or general causes should be treated. Acid substances, such as unsweetened lime juice and a mouth-wash of glycerin and lemon juice, may be useful.

Acute Septic Parotitis

(*Parotid bubo*)

Definition. Acute inflammation of the parotid gland.

Etiology. Acute septic parotitis is usually due to infection ascending the parotid duct. The causative organism is frequently the *Staphylococcus aureus*, less often the *Streptococcus viridans* or the *Streptococcus pneumoniae* (pneumococcus). It may occur in the absence of mastication, in fevers such as typhoid, in pneumonia, in facial paralysis, in cleft palate where an obturator is worn, in chronic uræmia, after operations on the abdomen, in treatment of peptic ulcer if a mouth-wash is not used regularly after the feeds, or in Sjögren's disease.

Clinical Findings. The patient complains of pain and swelling in the region of one parotid gland, with dysphagia and malaise.

On Examination : A tender parotid swelling is found with redness of the overlying skin. The patient is obviously ill.

Course and Complications. Suppuration usually occurs in the gland.

Prognosis. This is grave and death is not infrequent.

Treatment. The gland should be opened surgically as soon as fluctuation occurs; previously fomentations may be applied. Mouth-washes should be used frequently. If the infecting organism is penicillin-sensitive a course of intramuscular injections of 600,000 units of a procaine penicillin should be given every 12 hours for 5 to 7 days.

Acute Specific Parotitis (see Mumps, p. 580)

Chronic Parotitis

In chronic inflammation of the parotid glands, the other salivary glands are usually also affected. This may result from such causes as drugs (iodides, mercury or lead), syphilis, mumps, calculi and chronic nephritis. Treatment is directed to the underlying cause.

Mikulicz's Syndrome

Definition. A syndrome characterised by chronic swelling of the salivary and lacrimal glands.

Etiology. The cause of Mikulicz's syndrome is in some cases a low grade infection. Some authorities consider that Mikulicz's syndrome and Sjögren's disease are the same and that both are manifestations of systemic lupus erythematosus.

Pathology. Various types occur, varying from simple inflammation of the glands to leukaemia, lymphadenoma and lymphosarcoma. Syphilitic or tuberculous changes are rarely found in the glands.

Clinical Findings. The patient complains of swellings, gradually increasing in size, in the region of the eyes and face. There is interfer-

ence with vision, with some limitation of the temporal fields owing to the enlarged lacrimal glands, dryness of the eyes and mouth, but usually no pain.

On Examination: Swellings are seen in the region of the lacrimal, parotid and submaxillary glands, and there may be ptosis of the eyelids.

Differential Diagnosis. The gradual onset, absence of pain and the disposition of the swellings usually make the diagnosis clear. The *uveoparotid syndrome of Heerfordt* may be mistaken for Mikulicz's syndrome. Heerfordt's syndrome is a manifestation of sarcoidosis and there is enlargement of the parotid, submaxillary, and sometimes of the lacrimal glands, with inflammatory lesions in the uveal tract, and often facial paralysis, or more rarely polyneuritis. In Sjögren's disease there is dryness of the eyes, mouth, nose, pharynx, larynx and bronchi in addition to salivary gland enlargement. There may also be a polyarthritis and in some cases lupus erythematosus cells may be found in the blood.

Course and Complications. The course is usually chronic. Leukæmic or lymphosarcomatous changes may show themselves.

Treatment. Prednisolone, 5 mg. tab., 1 q.i.d. by mouth, may be tried for a week. The glands may be treated by X-rays, or surgical removal of the enlarged lacrimal glands may be followed by disappearance of the swelling of the salivary glands. Corticosteroids are not helpful in Sjögren's disease. One per cent methylcellulose eye drops may relieve the dryness of the eyes.

Tumours of the Salivary Glands

The majority of tumours of the salivary glands are mixed ones, containing myxomatous, fibrous and cartilaginous tissue, with a low grade of malignancy. They should be removed surgically and the scar afterwards treated with X-rays. The parotid gland is usually affected. Localised fatty infiltration of the parotid, simulating a mixed parotid tumour, has been described.

Salivary Calculi

Calculi, rarely bilateral, form usually in the submaxillary glands or ducts. They may give rise to painful swelling of the glands, especially provoked by foods which stimulate salivation or by acid substances. The calculus may be palpable or may only be seen by X-rays. It should be removed surgically.

THE ŒSOPHAGUS

Œsophagitis

Definition. Inflammation of the Œsophagus. This may be acute or chronic.

Acute Œsophagitis

Etiology. Acute Œsophagitis may be due to chemical irritants such as poisons (carbolic acid, caustic soda, perchloride of mercury or poison gases), to impacted foreign bodies, or it may be associated with

tuberculosis, diphtheria, monilia infection, syphilis or carcinoma. It may also occur in small-pox or typhoid fever.

Pathology. In cases of poisoning the lesion is usually situated at the lower end of the œsophagus. The changes vary from hyperæmia of the mucous membrane to abscess formation. Mediastinitis is often present.

Clinical Findings. There may be a history of any of the causative conditions described above. The patient complains of pain on swallowing and under the sternum, and there may be vomiting of blood and mucus. In severe cases there is fever with rigors and marked constitutional disturbance.

Differential Diagnosis. The history of the case and the dysphagia with retrosternal pain usually render the diagnosis clear.

Course and Complications. In mild cases the patient rapidly recovers. Perforation of the œsophagus or submucous abscess formation (phlegmonous œsophagitis) may lead to mediastinitis which is quickly fatal. Lesser degrees of ulceration may result in subsequent stenosis.

Prognosis. This varies with the cause and the degree of inflammation. There may be complete recovery, death, or subsequent stenosis.

Treatment. No food must be given by mouth until the patient is able to swallow a little olive oil without pain. Injections of morphin. sulph. $\frac{1}{8}$ to $\frac{1}{4}$ gr. (10 to 15 mg.) may be given during the acute stage. The possibility of subsequent stenosis should be remembered. Œsophagoscopy or an opaque meal will indicate any degree of obstruction with dilatation above it. Stricture should be prevented by the passage of bougies.

Chronic Œsophagitis

Etiology. Chronic œsophagitis may be due to alcoholism, achalasia of the cardia, hiatus hernia, frequent vomiting associated with pyloric stenosis, repeated passage of a stomach tube, tuberculosis, syphilis, actinomycosis, diverticula, new growths or a cerebral tumour.

Clinical Findings. The symptoms of chronic œsophagitis are usually indistinguishable from those of the underlying causes, which are described later. In addition there is usually a burning sensation in the back and under the lower third of the sternum. Repeated small hæmatemeses may occur, and œsophageal spasm will cause dysphagia.

Treatment. The diet should be soft and bland, and the following mixture given, Sod. brom. 10 gr. (0.6 G.), tnc. belladon. 15 m. (1 ml.), aq. chlorof. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s. In addition olive oil 60 to 120 m. (4 to 8 ml.) should be given immediately before each feed.

Œsophageal Obstruction

Etiology. The blockage may be due to: 1. Obstruction in the lumen as by impacted foreign bodies. 2. Changes in the walls (intrinsic causes) such as stenosis, congenital or acquired; the latter may be due to spasm. Other causes include fibrosis from ulceration (due to trauma, chemicals, diphtheria, new growth, or gumma) and tumours, especially

carcinoma. 8. External pressure (extrinsic causes) due to aneurysm, an enlarged thyroid, enlarged lymph nodes, mediastinal growth, pericardial or pleural effusion, pharyngeal or œsophageal diverticula, vertebral exostoses or new growths, or cervical caries.

Certain of these conditions will now be described in more detail.

Congenital Atresia

The œsophagus ends in communication with the trachea or a bronchus, so that food swallowed passes into the lungs causing cough and regurgitation. Less frequently the upper portion of the œsophagus ends blindly, the lower end communicating above with the trachea or a bronchus. Excessive mucus in the pharynx is usually noted at birth. Death usually occurs a day or so after birth.

Congenital Stenosis

The lumen of the œsophagus is narrowed, but there is no cicatrization. Clinically, regurgitation of food shows itself when the infant takes solids.

œsophageal Spasm

(œsophagismus)

Three varieties occur :—

1. *Primary œsophageal Spasm.* This is a neurosis. The patient experiences difficulty in swallowing, the bolus sticking in the gullet. Globus hystericus, hiccough or regurgitation of food may occur. The spasm is transitory and may take place at any level in the œsophagus.

Treatment. Cure can usually be effected by suggestion.

2. *Reflex œsophageal Spasm.* This may occur in association with local lesions such as a growth or ulcer in the œsophagus, or with inflammation of the gall-bladder or stomach.

3. *Plummer-Vinson Syndrome.* This is also known as the Paterson-Kelly syndrome or sideropenic dysphagia. It is probably caused by a disturbance of the neuro-muscular mechanism at the junction of the pharynx and œsophagus.

Pathology. There is absence of relaxation of the pharyngo-œsophageal sphincter.

Clinical Findings. The patient is often a woman, about the age of 40. There is difficulty in swallowing solids and in some cases liquids, the food sticking at the back of the throat.

On Examination : The tongue is smooth and may be sore. The pharynx is pale and dry. The skin is pale brownish-yellow, the nails are spoon-shaped (koilonychia) and there are cracks at the corners of the mouth (perlèche). The blood shows a microcytic hypochromic anæmia, with increased fragility of the red cells. It has been recorded with a normal blood count but a low serum iron level. Achlorhydria is frequently found, with a subnormal vitamin B₁₂ absorption. A barium swallow X-ray examination may show a post-cricoid web. This is a small fold of mucous membrane projecting into the lumen of the œsophagus, which can also be seen on œsophagoscopy. The spleen and liver may be enlarged.

Course and Complications. The course is progressive, if untreated. Carcinoma at the junction of the pharynx and œsophagus (post-cricoid carcinoma) and pernicious anæmia may occur as complications.

Treatment. This consists in the passage of a bougie and the administration of ferri et ammon. cit. 20 to 40 gr. (1·2 to 2·4 G) t.d.s. p.c. (see p. 527). Tab. Belladenal-Retard, one daily, is sometimes helpful.

Cardiospasm

(*Achalasia of the cardia. Idiopathic dilatation of the œsophagus.*

Phrenospasm. Hiatal œsophagismus)

Etiology. Obstruction occurs at the lower end of the œsophagus, due to failure of relaxation of the cardiac sphincter on deglutition, and caused by a disturbance of the neuro-muscular mechanism. There is probably no spasm of the right crus of the diaphragm. The cardiac sphincter consists of circular fibres, 1 inch (2·5 cm.) in depth and situated 1 to 2 inches (2·5 to 5 cm.) above the œsophago-gastric junction. Vagal stimulation causes contraction of the longitudinal fibres of the œsophagus and relaxation of the cardiac sphincters. Sympathetic stimulation has the reverse effect. Achalasia of the œsophagus may be due to fracture of the base of the posterior fossa of the skull, the last four cranial nerves being involved either by a hæmatoma or by the fracture passing through the jugular foramen and hypoglossal canal. This is known as Collett's syndrome. A case has been described in which there was complete achalasia at both the upper and lower ends of the œsophagus, associated with a fractured skull and hæmatoma. There may be a psychogenic element in cases of achalasia associated with emotion or grief.

Pathology. The œsophagus is dilated, and it may be lengthened and curved. There is inflammation of the mucous membrane and ulcers may form at the lower end of the œsophagus. The cardia is normal. There is degeneration of Auerbach's plexus in the cardiac sphincter in some cases. The œsophagus may hold as much as 3 pints (1·8 litres) instead of the normal 3 fl. oz. (90 ml.), and it may measure 12 inches (30 cm.) in diameter.

Clinical Findings. The patient is usually an adult over the age of 20, of either sex. He may give a history of discomfort on swallowing for many years, and later of regurgitation of solid food or at times of a feeling of obstruction. The patient may prefer to take his meals standing up. There is also often a choking sensation and sub-sternal pain. This occurs usually directly after swallowing, but, when much dilatation has taken place, vomiting may be delayed for half an hour or so. Œsophageal vomiting may occur during sleep. Achalasia of the cardia may ensue directly after the vomiting of pregnancy. Pressure symptoms may occur, such as dyspnoea, palpitations, and pain extending to the shoulders.

On Examination: The patient is not usually wasted except in advanced cases, and no physical signs are found. The opaque meal

carcinoma. 8. External pressure (extrinsic causes) due to aneurysm, an enlarged thyroid, enlarged lymph nodes, mediastinal growth, pericardial or pleural effusion, pharyngeal or œsophageal diverticula, vertebral exostoses or new growths, or cervical caries.

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On Examination: The patient is not usually wasted except in advanced cases, and no physical signs are found. The opaque meal

shows the dilated œsophagus above, and obstruction at the level of the diaphragm.

Differential Diagnosis. Other causes of œsophageal obstruction must be excluded, especially carcinoma of the œsophagus, a fibrous stricture resulting from a healed ulcer, and aneurysm. The barium meal and X-ray examination may suggest the irregular outline of a carcinoma, and a fractional test meal may show a curve suggestive of carcinoma of the stomach. Thus there may be high total acidity, no free HCl and some blood, if the fermenting contents are aspirated from the dilated œsophagus. Clinically, the long history, and absence of marked cachexia and wasting, negative this diagnosis, and œsophagoscopy excludes it.

Course and Complications. Remissions often occur in the early stages, but usually the condition becomes worse, if untreated. Hæmorrhage, the formation of a diverticulum, rupture of the œsophagus and general wasting may ensue. Carcinoma is a very rare complication.

Prognosis. This is favourable if proper treatment is given, especially if the condition has not existed very long.

Treatment. There is little evidence that psychiatric treatment is ever effective. The food should be soft and well chewed. In some cases, the inhalation of 3 m. (0.2 ml.) of octyl-nitrite from a crushable glass capsule, or from an inhaler, affords relief and even effects a cure. The drug may be inhaled before, directly after, or during a meal, and this treatment is worthy of trial in any case. If this fails, a mercury bougie should be passed, at first directly before every meal, and later at less frequent intervals. The bougie is a closed rubber tube, about $\frac{1}{2}$ inch (12.5 mm.) in diameter, containing mercury and weighing about 1 lb. 5 oz. (630 G.). The weight of the tube causes its passage, after swallowing, down the œsophagus and into the stomach. The patient soon learns to do this for himself, and, to begin with, the bougie should be left *in situ* for 10 to 15 minutes each time it is passed. Later, it is removed as soon as it has been passed. Many surgeons consider the mercury bougie should not be used. Surgical treatment consists in dilation of the sphincter by a solid bougie, rupture of the circular sphincter muscle fibres by a Negus dilator, or Heller's operation in which the circular muscle fibres at the lower end of the œsophagus are divided down to the mucous membrane. In other cases a lower œsophageal sympathectomy has been successful.

Carcinoma of the Œsophagus

Etiology. The cause is unknown. It may be associated with food irritants.

Pathology. The growth usually occurs in the upper or lower end of the œsophagus, or where it is crossed by the left bronchus. Three types occur—an ulcerative, a scirrhus, or, more rarely, a fungating form. It may infiltrate surrounding structures in the neck or mediastinum. The growth is usually of the squamous-celled variety, but the fungating form may be a columnar-celled adenocarcinoma arising from the mucous glands.

Clinical Findings. The patient is usually a male over the age of 40. He complains of dysphagia which may have a sudden onset, but more often comes on gradually, being first noticed on swallowing solids and later fluids. Subsequently vomiting occurs directly after swallowing, often of frothy material mixed with food. An early symptom may be substernal pain. The patient rapidly loses weight and becomes cachectic as the stenosis increases.

On Examination : In the early stages there are no physical signs. An X-ray examination with the screen and swallowed barium meal indicates the point of stricture and excludes the presence of an aneurysm. Œsophagoscopy will usually confirm the diagnosis. Blood may be present in the vomit or in the stools. Enlarged lymph nodes may be felt in the neck, especially above the left clavicle.

Differential Diagnosis. Other causes of œsophageal obstruction, such as aneurysm, achalasia and syphilitic stricture, must be excluded, as described above.

Course and Complications. The course is progressive. Complications such as perforation of the œsophagus, hæmorrhage and extension of the growth into the surrounding structures, such as the mediastinum and lungs, and septic bronchopneumonia may occur. The involvement of the mediastinum may give rise to deficient air entry into one or other lung, or to unilateral or bilateral recurrent laryngeal nerve paralysis.

Prognosis. Death usually occurs within 6 to 12 months from the onset of symptoms.

Treatment. This is largely palliative; an early gastrostomy may prolong life by enabling nutrition to be maintained by direct feeding into the stomach. To relieve dysphagia Souttar's tube may be used. This is "*a flexible spiral formed of German silver wire and gilded.*" It has an expanded upper end and a twisted oval section, which prevents displacement. It is introduced through the growth with an œsophagoscope, and allows the patient to swallow solid food. Alternatively, a polyvinyl chloride tube can be used. It is passed downwards through an introducer which has been passed up the œsophagus through a high anterior gastrotomy. The gastrotomy is then closed. Radium may be inserted into the œsophagus, or the growth treated with a radium bomb or by deep X-rays. Total excision is an operation with a high mortality rate, but a few successful cases have been recorded.

Sarcoma of the Œsophagus

This is much less common than carcinoma. It may form a polypoid or ulcerating growth.

Simple Tumours of the Œsophagus

Simple polypi may occur, giving rise to obstructive symptoms. Œsophagoscopy enables them to be diagnosed and removed. Other simple tumours include fibroma, fibromyoma, an accessory thyroid tumour and a simple cyst.

Syphilis of the Œsophagus

Etiology. Syphilis of the Œsophagus is usually due to acquired disease, rarely occurring in the congenital variety.

Pathology. In secondary syphilis there is inflammation of the mucous membrane. The lesions take the form of an Œsophagitis which may give rise to dysphagia. Gummata may occur in tertiary syphilis at the upper or lower end of the Œsophagus. These may ulcerate. Leukoplakia is often seen in the mouth and in the Œsophagus. Obstruction is intensified by muscular spasm.

Clinical Findings. The patient is usually an adult of either sex who complains of progressive dysphagia. There is commonly no pain unless the pharynx is also involved. Signs of syphilis may be found elsewhere. The blood Wassermann reaction may be negative, but that of the cerebrospinal fluid is usually positive.

Differential Diagnosis. This can only be made with certainty by Œsophagoscopy, as a positive Wassermann reaction due to syphilis elsewhere may occur in association with a carcinoma of the Œsophagus.

Course and Complications. Progressive stenosis usually develops if the lesion is left untreated.

Prognosis. This is very favourable with adequate treatment.

Treatment. A full course of anti-syphilitic treatment should be given (see p. 600). Stenosis should be prevented by repeated dilatation with bougies.

Diverticula of the Œsophagus

Definition. Pouches formed by herniation of the Œsophageal mucous membrane through the muscular coat.

Etiology. There are two varieties: 1. *Traction Diverticula.* These are caused by adhesions between the Œsophagus and chronically inflamed tuberculous bronchial lymph nodes, at the bifurcation of the trachea. 2. *Pulsion Diverticula.* These are due to increased internal pressure associated with swallowing food and weakness of the Œsophageal wall.

Pathology. Traction diverticula are usually small and the whole coat of the Œsophagus is involved. They arise from the anterior wall, near the tracheal bifurcation. Pulsion diverticula may be small or large. The pharyngo-Œsophageal (pharyngeal) diverticulum arises from the posterior wall of the pharynx at the weak spot just above the crico-pharyngeal muscle. The opening is immediately above the superior opening of the Œsophagus. The diverticulum usually passes to the left and thence forward. Small pulsion diverticula may arise laterally in the lower part of the Œsophagus.

Clinical Findings. Diverticula usually give rise to no symptoms unless they are sufficiently large to interfere with deglutition. Accumulations of small quantities of food may cause an unpleasant taste, regurgitation of food may occur especially on stooping, or a swelling may be noticed in the neck which diminishes after regurgitation, causing dysphagia or cough.

Differential Diagnosis. A swelling in the neck which disappears

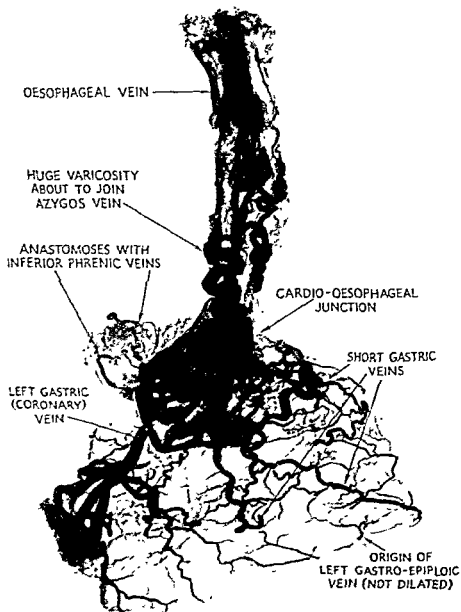


FIG. 1. Oesophageal and Gastric Varices Photographed after Injection with Bismuth.

after regurgitation of food is very suggestive. An X-ray examination after swallowing a barium paste usually confirms the diagnosis.

Course and Complications. A large diverticulum may cause œsophageal obstruction owing to pressure of its contents.

Treatment. Small diverticula are usually only diagnosed by X-ray examination and require no treatment. A larger diverticulum in the neck can be removed by operation. The rarer varieties in the thorax are usually intractable. Sometimes the patient can swallow more easily if he lies on his face.

Œsophageal Varices

Varicose veins in the lower part of the œsophagus are a common post-mortem finding (see Fig. 1). They are usually associated with cirrhosis of the liver, consequent on portal vein stagnation. They may also occur with obstruction of the inferior or superior vena cava, as in heart failure. They are a cause of hæmatemesis or melæna and can be diagnosed during life by œsophagoscopy, or by a barium swallow, the film showing a characteristic appearance.

Œsophageal Ulceration

The following varieties of ulcer may occur: Traumatic, peptic, simple as a complication of fevers such as diphtheria or scarlet fever, malignant, syphilitic, and tuberculous. Peptic ulcers occur at the lower end of the œsophagus, especially in association with thoracic stomach. They cause pain on swallowing at the lower end of the sternum and in the back. Vomiting and hæmatemesis may occur. The diagnosis of ulceration is made by œsophagoscopy, and the treatment is as for gastric ulcer (see p. 86), but olive oil 60 to 120 m. (4 to 8 ml.) should be given immediately before each feed.

Rupture of the Œsophagus

This may occur spontaneously when ulceration is present, or from trauma caused by an ingested foreign body or the passage of an œsophagoscope or bougie. It may rarely follow vomiting. Thus in one of my cases a patient after rapidly drinking several glasses of beer, vomited violently and was seized with acute pain in the left side of the chest and left flank. He sat up and writhed in agony.

On Examination: The abdominal wall was rigid and a pleural rub was heard over the left lower chest in front. The pulse was rapid, and the temperature subnormal. In a few hours signs of a left hydropneumothorax were present, acid stomach contents were aspirated from the lower left chest and air was present above. Death ensued in about 80 hours, and at autopsy a rent was found in the œsophagus just above the diaphragm. Cure has been reported by thoracotomy and repair of the tear.

Dilatation of the Œsophagus

This may be a uniform dilatation occurring above an œsophageal obstruction (see Dysphagia) or be due to achalasia of the cardia. Localised dilatation occurs as a diverticulum.

Dysphagia

Definition. Difficulty in swallowing.

Etiology. The causes may be classified as oral, pharyngeal, laryngeal and œsophageal. The most important causes are :—

Oral. Stomatitis; ulcers of the tongue; sore throat as in tonsillitis; quinsy; cleft palate; palatal and pharyngeal paralysis as in diphtheria, bulbar palsy, myasthenia gravis, and progressive muscular atrophy; mumps; fractured jaw; arthritis of the jaw; dislocated jaw.

Pharyngeal. Retropharyngeal abscess; diverticulum; syphilitic stenosis; achalasia of the pharyngo-œsophageal sphincter (Plummer-Vinson syndrome).

Laryngeal. Tuberculous laryngitis; carcinoma of the larynx.

Œsophageal. Internal: Ingested foreign body such as a bone. Intrinsic: Œsophagitis; ulcer; stricture; spasm; globus hystericus; tumours; diverticula; achalasia of the cardia; paralysis (bilateral lesions of the vagus). External: Enlarged cervical lymph nodes; tumours of the thyroid; mediastinal tumours; aneurysm of the aorta; dilatation of the left atrium; dissecting aneurysm; congenital abnormalities such as right-sided aortic arch, double aortic arch and aberrant right subclavian artery; pleural or pericardial effusion; unilateral pulmonary fibrosis.

THE STOMACH

Introductory. In the majority of cases of disorders of the stomach the physical signs are slight and inconclusive, and diagnosis depends on a very careful investigation of the history and symptoms, and on special investigations by test meals, opaque meals and gastroscopy.

Gastritis

Definition. Inflammation of the mucous membrane of the stomach. This may be acute or chronic.

Acute Gastritis

Etiology. Acute gastritis usually results from the ingestion of some irritant such as articles of food either indigestible, unmasticated or tainted (food poisoning), from excessive amounts of alcohol, from poisons such as perchloride of mercury or from the inhalation of an irritant gas. In children, it forms a part of summer diarrhœa (acute gastro-enteritis). Acute gastritis may occur in influenza, uræmia, pneumonia, bronchitis, and rarely in typhoid or typhus fevers. The infection here is probably hæmatogenous. In pyæmia and small-pox suppurative gastritis may occur.

Pathology. The mucous membrane of the stomach is red and inflamed, and hæmorrhages may occur. In infective cases there may be local or diffuse suppuration in the submucous tissues (phlegmonous gastritis) and this may cause perforation of the stomach wall.

Clinical Findings. The patient is usually an adult who gives a history of one of the causative conditions enumerated above. He

complains of being suddenly taken ill with pain in the epigastrium followed often by vomiting and thirst. The vomit at first consists of stomach contents, but later there is usually little beyond mucus, gastric juice, and possibly blood. In severe cases there are general toxic symptoms with prostration, faintness, pallor, subnormal temperature and a rapid feeble pulse. The temperature may be raised in cases due to food poisoning. If the irritant enters the intestine there may also be diarrhoea.

Differential Diagnosis. The diagnosis is usually clear from the history and picture of the case. The vomit should be examined in order to determine, if possible, the cause of the illness. The acute abdominal pain may suggest abdominal angina or a tabetic crisis, and acute phlegmonous gastritis is usually mistaken for a perforated appendix or peptic ulcer.

Course and Complications. In the majority of cases the illness is of short duration, and complications, apart from diarrhoea, are rare. In severe cases the sequelæ include ulceration of the stomach, chronic gastritis and gastric stenosis.

Prognosis. This depends on the nature of the irritant. Death is inevitable with phlegmonous gastritis, and may occur rapidly in poisoning cases.

Treatment. If poisoning is suspected, a specimen of the vomit should be saved in a clean jar for special tests to determine the nature of the irritant. The patient should be put to bed and only sips of water allowed by mouth. The bed should be warmed with hot bottles. In cases of poisoning not due to a corrosive substance, a stomach tube should be passed and the stomach washed out. In poisoning due to corrosives the appropriate antidote should be given. Subsequently only small quantities of water are allowed by mouth (see p. 785).

In cases not due to poisoning a preliminary dose of castor oil $\frac{1}{2}$ fl. oz. (15 ml.) should be given, followed by a gastric sedative, such as Sod. bicarb. 10 gr. (0.6 G.), bism. carb. 15 gr. (1 G.), acid. hydrocyan. dil. 2 m. (0.12 ml.), muc. acac. $\frac{1}{2}$ fl. oz. (15 ml.), aq. ad. 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) every 4 hours.

To relieve epigastric pain, hot flannels or a mustard leaf may be applied. If there has been much loss of fluid by vomiting, rectal injections of 4 to 8 fl. oz. (120 to 240 ml.) of normal saline containing 5% dextrose should be given every 4 to 6 hours. In cases of severe collapse a stimulant such as nikethamide (Coramine) 2 ml. should be injected hypodermically, and 4 fl. oz. (120 ml.) of strong hot coffee may be administered per rectum.

Food should be given with caution when vomiting and acute pain have ceased. Three ounce (90 ml.) feeds of citrated milk, 2 gr. (0.12 G.) to 1 fl. oz. (30 ml.), or arrowroot every 2 hours are most suitable.

Chronic Gastritis

Etiology. It is doubtful whether many of the conditions which were formerly described as causing chronic gastritis do in reality have this effect. Thus the stomach may be gastroscopically normal in many

individuals who have consumed considerable amounts of alcohol for many years. Chronic gastritis may be secondary to acute gastritis, to local causes such as an ulcer or growth in the stomach, or to passive venous congestion in association with cirrhosis of the liver and heart failure. Chronic gastritis may also occur in wasting diseases such as carcinoma or tuberculosis, or in blood diseases such as pernicious anæmia or leukæmia.

Pathology. Gastrosopic and other studies of the mucous membrane, including gastric biopsy using a flexible tube, reveal three types, superficial, atrophic and hypertrophic gastritis. In superficial gastritis there is reddening, œdema and exudation. In atrophic gastritis the mucous membrane is thin and pale. In hypertrophic gastritis the mucous membrane is velvety. It may be nodular or polypoid, and small erosions may be seen.

Clinical Findings. Superficial gastritis usually gives rise to no symptoms. Atrophic gastritis may be met with in untreated pernicious anæmia, in iron deficiency anæmias and in gastric carcinoma. The symptoms are inconstant, but the patient may complain of dyspepsia and heartburn. In hypertrophic gastritis the symptoms may resemble those of peptic ulcer, and a severe hæmatemesis may occur.

Treatment. In atrophic gastritis the treatment appropriate for the anæmia should be given. In hypertrophic gastritis the treatment is as for gastric ulcer.

The Gastric Dyspepsias

Definition. Disturbances of stomach function.

Etiology. The main function of the stomach is to liquefy food and pass it on to the duodenum. Disturbances of function may be secretory, muscular or nervous.

Hypochlorhydria and Achlorhydria

Definition. Diminished secretion of gastric juice. The term is usually employed to mean diminished secretion of hydrochloric acid.

In achlorhydria there is absence of free hydrochloric acid, and in achylia gastrica there is a complete absence of free hydrochloric acid and pepsin in the gastric juice.

Etiology. Hypochlorhydria may be met with in apparently healthy individuals. Achlorhydria may also occur in apparently healthy individuals or may result from atrophic gastritis or carcinoma of the stomach. It may also occur with simple achlorhydric anæmia. Achlorhydria is more common in women. It is rare with duodenal ulcer, less uncommon with gastric ulcer. Achylia gastrica is usually present with pernicious anæmia.

Clinical Findings. Frequently there are no symptoms. In other cases the patient, usually an adult, complains of abdominal discomfort and fulness after a small meal, flatulence, anorexia, heartburn and diarrhoea. A test meal shows a complete absence of free hydrochloric acid and a low total acid curve. The opaque meal shows rapid stomach emptying due to absence of acid in the duodenum. Normally acid in

the duodenum causes the pylorus to close until it is neutralised by the pancreatic secretion.

Treatment. This should be directed to the associated conditions, such as anæmia. It is doubtful whether hydrochloric acid given by mouth has any effect.

Hyperchlorhydria

Definition. In hyperchlorhydria the volume of gastric juice may not be increased, but the concentration of hydrochloric acid is greater than the normal of about 0.1 to 0.2%, as obtained with the test meal.

Etiology. Hyperchlorhydria occurs in about 5% of apparently normal men, or in association with pylorospasm and juxta-pyloric ulcer, the gastric crises of tabes, and at times in association with chronic cholecystitis or appendicitis.

Clinical Findings. No definite symptoms can be attributed to hyperchlorhydria.

Gastric Flatulence and Aerophagy

(Flatulent Dyspepsia)

Definition. Distention of the stomach with gas.

Etiology. Flatulence is frequently due to air swallowing (aerophagy), less often it is due to fermentative changes in the stomach.

Clinical Findings. The patient complains of epigastric distention after meals, fulness and eructations of wind. Flatulent dyspepsia is a prominent symptom in many cases of gall-bladder disease. It often gives rise to palpitations and pain near the apex of the heart, which is mistaken by the patient for heart disease. As a psychoneurosis, aerophagy becomes a morbid habit, the patient constantly swallowing and belching up wind, with noises which are very distressing for those near him. Aerophagy may also occur with acute dilatation of the stomach.

Treatment. In flatulent dyspepsia the meals should be given dry, and fluid drunk half an hour before, or 2 hours after meals. A charcoal biscuit may be eaten or a carminative such as ol. cajaput. 2 m. (0.12 ml.) or ol. terebin. 10 m. (0.6 ml.) may be taken on sugar, or a mixture ordered containing Sod. bicarb. 10 gr. (0.6 G.), sp. ammon. aromat. 20 m. (1.2 ml.), sp. chlorof. 5 m. (0.3 ml.) infus. caryophyll. rec. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) three times daily after meals.

In aerophagy due to nervous causes the nature of the air swallowing should be explained, and the patient instructed to resist all desire to "bring up" the wind. Holding a cork between the teeth may prevent air swallowing.

Bulimia

A condition of excessive hunger which may be met with in diabetes mellitus, gastric ulcer, hyperthyroidism, gout, or as a neurosis.

Anorexia Nervosa

A condition characterised by complete loss of appetite without any organic cause being discoverable. The loss of appetite was attributed

by Sir William Gull to a "morbid mental state," and it is thought by some that this leads to a functional disturbance of the anterior lobe of the pituitary. The condition in some ways resembles Simmonds' disease. The latter, however, usually occurs at a later age period. Predisposing causes include emotional crises, unhappiness at home, at school or at work, "slimming," an operation, or a severe illness. The patient is usually a young woman aged 15 to 20 years, who refuses to take any food, steadily loses weight and suffers from amenorrhœa. The amenorrhœa may begin before, or at the same time as the anorexia. There is an increased downy growth of hair on the trunk, limbs, lips and chin, and the pubic hair may show the male distribution. There is usually no loss of pubic or of axillary hair. In severe cases there is œdema of the legs. The patient is active and restless and displays complete indifference towards her symptoms. Death, usually from starvation, may occur from what is apparently a functional disease.

The nature of the illness should be explained to the patient and her relatives. Small feeds should be given two-hourly, the nurse or doctor ensuring that these are eaten. Feeding by continuous intragastric drip, the tube being passed through the nose, is very successful in some cases. The patient cannot be considered to be cured until her monthly periods are restored. Good results have been obtained "by using very large doses of chlorpromazine, combined if necessary with modified insulin treatment."

Heartburn

(*Pyrosis*)

Heartburn is a burning sensation felt behind the sternum or in the epigastrium, usually accompanied by eructations or regurgitation of a little acid fluid into the mouth. It often occurs in the early months of pregnancy, or in association with smoking or taking a meal when fatigued by the day's work. In other instances it is associated with an organic disease of the œsophagus, stomach or gall-bladder. Relief may usually be obtained by drinking a little warm water with half a teaspoonful (2 G.) of sodium bicarbonate dissolved in it.

Waterbrash

Waterbrash is a regurgitation of acid fluid into the œsophagus accompanied by a copious secretion of saliva. The latter may run out of the mouth and be followed by vomiting. It is usually associated with hypersecretion and relieved by alkalis.

Dilatation of the Stomach

(*Gastrectasis*)

There are two types, acute and chronic.

Acute Dilatation of the Stomach

Etiology. The dilatation may be due to paralysis of the gastric branches of the vagus or to overactivity of the sympathetic, associated with a kink of the third part of the duodenum, where it is crossed by the superior mesenteric vessels. This kink is produced by the drag of

the dilated stomach. Some writers believe that the dilatation is initiated by air swallowing. Attacks may occur in the progressive muscular dystrophies. It usually follows operations such as prostaticectomy, but it may occur in any severe illness, after childbirth, after injuries to the spine, femur or head, or following a heavy meal.

Clinical Findings. Shortly after coming round from the anæsthetic after an abdominal operation the patient notices pain or oppression in the epigastrium, and later large quantities of watery fluid containing mucus or bile pour out from the mouth.

On Examination: In the early stages there is slight fulness in both hypochondria. Later the patient is pale and collapsed, the abdomen is distended and sometimes tender; a stomach splash is elicited. The pulse is rapid and of poor volume, and the temperature is usually subnormal.

Differential Diagnosis. Acute dilatation of the stomach must be differentiated from peritonitis or intestinal obstruction. The absence of fever and faecal vomiting, together with the signs of a grossly dilated stomach, are characteristic findings.

Course and Complications. If untreated it may prove rapidly progressive.

Prognosis. This is serious, and death may quickly occur unless treatment proves successful.

Treatment. Prophylactic. This consists in the avoidance of tight abdominal binders after operations. Mouth-washes should be used to prevent air swallowing.

Curative. If the condition is diagnosed sufficiently early and adequate treatment applied, it is not usually necessary to place the patient in the knee-elbow position or on his face. As soon as it is suspected a Ryle's tube should be passed through the nose, and the stomach contents aspirated with a well-fitting glass syringe. If excessive fluid is obtained, indicating dilatation, the stomach should be kept empty by a continuous suction apparatus attached to the Ryle's tube. Normal saline should be given intravenously by the continuous drip method to replace lost fluid, and the patient should be allowed fluid by mouth as desired. Physostigmine salicylate $\frac{1}{200}$ gr. (0.3 mg.), or Prostigmin 1 mg., should be given subcutaneously every 4 hours for 8 doses.

Chronic Dilatation of the Stomach

This may be non-obstructive or obstructive.

Non-obstructive Dilatation of the Stomach

It is doubtful whether the large stomach, often associated with gastropsis, gives rise to a definite symptom complex.

Obstructive Dilatation of the Stomach

Etiology. Obstructive dilatation may result from pyloric obstruction due to an ulcer, new growth, congenital stenosis, pylorospasm or external adhesions, or to an hour-glass stomach.

Pathology. The stomach is usually considerably enlarged and some hypertrophy of its musculature may occur.

Clinical Findings. The patient is often an adult male, who complains of indigestion associated with gradual weakness. There is epigastric discomfort, flatulent distention and periodical vomiting of large quantities of sour fluid, which has an offensive odour in malignant cases. The vomit often contains articles of food eaten several days previously. The appetite may remain good but constipation is severe.

On Examination : A marked stomach splash may be elicited several hours after the last meal and in some instances pyloric thickening is felt. Visible peristalsis, in which the waves pass from left to right in the upper abdomen, may be noted after abdominal palpation, and the outline of the distended stomach may be seen through a thin abdominal wall. Occasionally antiperistaltic waves are seen. A test meal shows stagnation of the stomach contents, excess of mucus, fermentation acids and a low or absent free hydrochloric acid content. An opaque meal indicates the size of the stomach and delay in emptying. This may be repeated after a course of tnc. belladon. 15 m. (1 ml.) t.d.s., which is given for 3 to 4 days to see whether the obstruction is due to pylorospasm. Pylorospasm may be due to apprehension, and some radiologists believe that the relaxation of the spasm at the second examination is due to the relief of this apprehension rather than to the effect of the belladonna.

Course and Complications. Organic pyloric stenosis is progressive, and, if due to carcinoma, usually rapidly so. Tetany may occur as a complication.

Differential Diagnosis. Dilatation of the stomach can usually be distinguished from dilatation of the colon by clinical examination, and, in some cases of the latter, removal of flatus by a rectal tube establishes the diagnosis. If the stomach is grossly dilated and filled with fluid, ascites or an ovarian cyst may have to be eliminated in making the diagnosis. There is usually no difficulty, as the dilated stomach can be emptied by a tube and the swelling thus removed. X-rays also serve to establish the diagnosis.

Prognosis. This depends on the cause of the obstruction and its amenability to treatment.

Treatment. Gastro-enterostomy is usually required in organic obstruction. Stenosis due to spasm may be relieved by daily gastric lavage and the administration of tnc. belladon. 15 m. (1 ml.) t.d.s.

Congenital Hypertrophic Stenosis of the Pylorus

Etiology. The stenosis is probably due to congenital hypertrophy of the circular fibres of the pylorus with superimposed pyloric spasm. **Predisposing causes :** 1. Age : 2 to 4 weeks. 2. Sex : Males predominate in the proportion of four to one. The first child of a family is especially prone to the affection. Phimosis is probably of no etiological significance.

Pathology. There is pyloric thickening with hypertrophy of the

circular muscle fibres ; the stomach may be dilated. The duodenum is normal.

Clinical Findings. The patient is usually a baby boy, either breast or bottle fed, aged about 2 to 4 weeks, who was healthy at birth, but who has suffered from vomiting and constipation since he was about 2 weeks old. More rarely the vomiting has been present from birth. The vomiting is forcible or projectile, the fluid being ejected 2 to 3 feet (60 to 90 cm.), and the baby loses weight. The vomit does not contain bile.

On Examination : The baby is often pale, a little cyanosed and wasted and may appear dehydrated. Visible peristalsis, from left to right, may be seen in the epigastrium after a feed. A tumour can be felt in nearly every case if sufficient care is taken. The warmed left hand is laid on the abdomen and the lower border of the liver defined. Pressure is then made with the fingers in the region of the pylorus, and after the baby is fed the small tumour due to the thickened pylorus can usually be felt. It may be under the liver and felt only on inspiration and it may quickly relax. An X-ray photograph may be taken, giving an ounce (30 ml.) of milk and water and 60 gr. (4 G.) of barium sulphate by a spoon ; the delay in stomach emptying is thus revealed. Gastric analysis usually shows a high free and total acidity and absence of duodenal regurgitation. The vomiting leads to alkalosis, with a raised plasma bicarbonate and a lowered plasma chloride figure.

Course and Complications. If untreated, the baby usually dies in a few weeks from starvation ; recovery may take 1 to 3 months with medical treatment. Gastro-enteritis due to cross-infection in a hospital ward is a serious complication.

Differential Diagnosis. The condition must be diagnosed from other causes of vomiting. The characteristic features are the age of onset, the projectile vomiting, visible peristalsis, and, most important, the palpable tumour. In congenital duodenal stenosis the vomiting begins at birth and bile is present in the vomit.

Prognosis. A certain proportion of patients recover spontaneously, but, as it is impossible to say whether an individual one is going to do so, treatment should be given immediately the diagnosis is made. There is a difference of opinion as to whether this treatment should be medical or surgical, and whether surgical treatment should only be given if medical fails. On statistical evidence the palm must be awarded to the surgeons, as in a series of 50 cases operated on in nursing homes 100% recovered, and with a series of 100 cases, who were *breast-fed* before and after the operation, and were operated on in hospital, all recovered. On the other hand, with bottle-fed infants operated on in hospital, a mortality of 10% may be expected, death being usually due to gastro-enteritis acquired by cross-infection in hospital.

Treatment. Medical. This consisted formerly of gastric lavage, using a No. 6 or 7 Jacques soft rubber catheter and a 1% sodium chloride solution at 100° F. (37·8° C.), twice daily just before a feed. Small hourly feeds were given of 1 to 2 teaspoonfuls (4 to 8 ml.) of breast milk which had just been drawn off, or of citrated or peptonised

milk. The feeds were gradually increased to $1\frac{1}{2}$ fl. oz. (45 ml.). The best medical results are obtained by the use of Eumydrin (atropine methylnitras). Eumydrin may be given by mouth using a 1 in 10,000 solution in water, the first dose is 0.5 to 1 ml., increasing by 0.5 ml. at each feed until 2 to 3 ml. are given six times daily. The Eumydrin is administered half an hour before the feeds, which are given three-hourly. The treatment has to be continued for about 4 weeks. Eumydrin (0.6% in alcohol) may also be given by drops applied to the tongue. One drop twice a day may prove sufficient to stop the vomiting. It is a mistake to administer too much fluid by mouth, or in the form of normal saline subcutaneously, unless the patient is very dehydrated, as this diminishes the effect of the drug. The total fluid required (between feeds) is 3 fl. oz./lb. body weight (190 ml./kg.) during the first 24 hours, subsequently the infant is given by mouth between feeds as much fluid as he requires in addition to his feeds. Gastric lavage is not usually necessary. Toxic effects include rise of temperature, flushing of the skin and abdominal distension. These can usually be relieved by omitting the next dose of Eumydrin. The duration of the treatment is likely to be 28 days in hospital. If a favourable result is not obtained in a few days, an operation should be performed.

Surgical. The operation is that of Rammstedt's pyloromyotomy, the pylorus being divided longitudinally down to the mucous membrane. It is usually performed under local anaesthesia, the stomach being washed out immediately before the operation.

Hypertrophic Stenosis of the Pylorus in Adults

A few cases of hypertrophic stenosis of the pylorus of the congenital type have been met with in adults. They are characterised by recurrent attacks of vomiting which may be associated with tetany, without necessarily a history of infantile vomiting. The condition can be cured by pyloroplasty, if feasible, or relieved by gastro-enterostomy.

Cascade Stomach

This radiological abnormality is also known as the "cup and spill" deformity, or as the physiological hour-glass stomach. It probably results from an indentation of the posterior wall of the fundus of the stomach. This may be due to distension of the splenic flexure with gas, or to localised gastric spasm. The barium fills the lower part of the fundal loculus, and then spills down into the lower part of the stomach. The patient may complain of recurrent attacks of epigastric pain, nausea and vomiting. No special treatment is required. Volvulus of the stomach is probably a variant of the cascade stomach.

Hæmatemesis

Definition. Vomiting of blood.

Etiology. The blood may be derived from various sites :—

The Stomach (gastrorrhagia).

Local causes: Erosion (gastrostaxis, bleeding from minute foci); ulcer; carcinoma or sarcoma; hypertrophic gastritis; trauma; corrosives; aspirin tablets swallowed whole; simple tumours such as polypi or angiomas; a tuberculoma; a gumma. Intra-gastric rupture of aneurysm of the aorta. *Tabes dorsalis* (gastric crises).

Portal congestion due to cirrhosis hepatis; splenic anæmia; heart failure; thrombosis of the portal vein.

Toxic and infective causes: Yellow fever; Weil's disease; small-pox; hæmorrhagic diphtheria; hæmorrhagic scarlet fever; hæmorrhagic measles; appendicitis; cholecystitis; septicæmia; influenza; cholæmia; uræmia.

Blood diseases: Leukæmia; purpura; pernicious anæmia; hæmophilia; erythæmia.

The Oesophagus: Ruptured varicose veins in cirrhosis of the liver.

The Duodenum. An ulcer.

The Lungs, Nose or Mouth. The blood from these sources is swallowed before it is vomited.

Clinical Findings. If the hæmatemesis is severe, the patient usually experiences a preliminary feeling of faintness with nausea, and then vomits up the blood. Blindness, temporary or permanent, may follow hæmatemesis.

On Examination: The patient is often pale and blanched. The vomited blood tends to be dark (coffee grounds) and is acid in reaction unless a large dose of alkali has been taken just before the vomiting. Food may be present in the vomit and the blood is not aerated, as in hæmoptysis. The stools subsequently are dark and tarry (*melæna*) for about two days after the bleeding has ceased.

Treatment. This depends on the cause. The routine treatment for hæmorrhage due to gastric ulceration is described on p. 37.

Vomiting

Definition. Expulsion of the stomach contents from the mouth by abdominal and diaphragmatic contractions.

Etiology. Vomiting may be due to:—*Gastric Causes:* Dyspepsia; gastritis; ulcer; carcinoma; congestion in heart failure or cirrhosis; hour-glass constriction; pyloric obstruction; emetics such as salt or mustard; irritants such as arsenic, digitalis, poison gases, etc.

Central Causes: Stimulation of the vomiting centre in the medulla by anæsthetics; apomorphine; tobacco; toxins in uræmia; alkalosis; acidosis in diabetes mellitus and cyclical vomiting; cholæmia; pregnancy; Graves' disease; Addison's disease; scarlet fever; influenza; massive necrosis of the liver.

Nervous Causes: Emotions; hysteria; migraine; concussion; meningitis; intracranial tumours, abscess or hæmorrhage; *tabes dorsalis*.

Reflex Causes: Pharyngeal irritation; intestinal obstruction; appendicitis; worms; peritonitis; acute pancreatitis; biliary colic; renal colic; Dietl's crisis; vestibular causes as in Ménière's disease

and possibly seasickness; nasal causes, due to odours; uterine and ovarian irritation, as in pregnancy; testicular trauma.

Gastric Ulcer

(Peptic Ulcer)

Definition. A simple ulcer of the stomach of doubtful etiology.

Etiology. The cause is unknown. Gastric juice appears to be an essential factor in the ulcer production, as peptic ulcer occurs only in situations exposed to its action, such as the stomach, first part of the duodenum, last part of the oesophagus, and in the jejunum after gastric anastomosis (anastomotic ulcer). Normally the gastric mucosa is protected from the corroding action of the acid by a thin layer of mucus. Extensive skin burns may result in a Curling's ulcer. This is an acute gastro-duodenal ulcer, situated near the pylorus. A peptic ulcer may develop in an area of heterotropic gastric mucous membrane in a Meckel's diverticulum. In the Zollinger-Ellison syndrome there is an association of multiple gastro-intestinal ulcers, non-insulin-secreting islet-celled adenomata of the pancreas and massive hyperchlorhydria. This may be associated with watery diarrhoea and potassium depletion. It may be cured by removal of the pancreatic lesion. Other factors which may play a part in its production are: Trauma from ingested irritant food. Chronic gastritis. Gastric arterial thrombosis or cardiac infarction. Nervous disturbances, such as over-activity of the vagus or under-activity of the sympathetic, which may result from tobacco. Worry appears to predispose to hæmorrhage and perforation. Stimulation of a vegetative centre in the inter-brain by Pituitrin or by a tumour, with consequent increased vagal activity, may be a factor. The posterior lobe of the pituitary in animals produces a gastrototoxic substance which can cause lesions in the acid-bearing area of the stomach. There may also be a gastric ulcer diathesis, as gastric ulcers tend to run in some families and duodenal ulcers in others.

Pathology. The ulcer varies in size from about 4 to 30 mm. in diameter, but it may be larger; it is usually about the size of a shilling (24 mm. in diameter) and is commonly circular or oval. Multiple ulcers may occur. Acute and chronic ulcers are described. The former are usually small and often multiple, their floor is smooth and adhesions are not found. They may form rapidly, in four or five days. In chronic ulcers there may be much fibrosis producing pyloric stenosis or hour-glass constriction of the stomach. The following are the most frequent sites: Near the pylorus, on the lesser curvature, on the posterior wall, on the anterior wall and cardia, on the greater curvature. The ulcer is sharply delineated and extends a variable distance through the stomach wall. It may erode and perforate the stomach wall, or be surrounded by inflammatory tissue, or become adherent to such organs as the pancreas.

Other changes found in association with gastric ulcer are perforation of an artery in the ulcer, perigastric suppuration due to localised peritonitis which may cause a subphrenic abscess, generalised peritonitis from perforation, fistulæ with the colon, duodenum or pleura, and peri-

gastric adhesions to the liver, gall-bladder, etc. Carcinoma rarely develops in an old gastric ulcer, but healing with a resultant scar is not infrequent.

Clinical Findings. The first symptom of an acute ulcer is usually hæmatemesis and rarely perforation. The patient is usually an adult, over the age of 20, although a gastric ulcer has been recorded in a child aged three months. There is a history of periodic attacks of indigestion. The characteristic features of the attack are epigastric pain appearing a quarter of an hour to one hour after food and disappearing before the next meal. The pain is believed to be caused by muscular contractions or spasm of the stomach. It may be felt in the epigastrium to the left of the mid-line or near the xiphoid process and may pass through to the back near the angle of the left scapula. It is often relieved by vomiting or by alkali medicines. Other symptoms such as nausea, vomiting, hæmatemesis or melæna may occur. In some instances, especially when the ulcer is on the lesser curvature of the stomach or near the cardiac end, there are no symptoms until a severe hæmatemesis occurs. When the ulcer is situated close to the pylorus, the symptoms resemble those of a duodenal ulcer. The appetite is often good, but the patient is afraid to satisfy it. Other symptoms such as heartburn or flatulence with epigastric distention may be troublesome.

On Examination: The patient is often well nourished, but the tongue is usually furred. Tenderness and cutaneous hyperalgesia may be found in the epigastrium, the tender spot corresponding with the site of the pain, as demonstrated by the patient with his finger tip. Some muscular rigidity of the upper rectus muscle may be felt on one or both sides. An opaque meal may demonstrate the ulcer as a projecting mass of barium in the lesser curvature, in other cases a niche or permanent filling defect may be seen in the stomach wall. Pyloric spasm may be present with juxta-pyloric ulceration. An incisura or hour-glass constriction may be noted in some cases with mid-gastric ulcers. If a constriction of the stomach wall is noticed, the opaque meal should be repeated after the patient has been given a course of belladonna, such as tnc. belladon. 15 m. (1 ml.), t.d.s. a.c. for 3 to 4 days, to see if the constriction is due to spasm or to organic deformity. A muscular spasm is often seen in the stomach wall opposite the site of the ulcer. A fractional test meal shows a climbing type of curve with high acidity if the ulcer is near the pylorus and pylorospasm is present. Blood may be found in the specimens removed. In at least 50% of cases the test meal findings are normal, especially if the ulcer is not juxta-pyloric. In some cases gastroscopy will reveal an ulcer which is not demonstrable radiologically; the converse is also true. The Olympus gastro-camera gives more valuable results than does gastroscopy. Good photographs are obtained in the lower half of the stomach. A gastro-jejunal stoma is not always easy to see. The fæces: The occult blood test may be positive. There are many atypical cases in which the history and symptoms do not suggest gastric ulcer, and yet its presence is revealed by the opaque meal.

Differential Diagnosis. In very many cases a presumptive diagnosis

of gastric ulcer can only be made after X-ray and test meal examinations, the symptoms and signs being entirely misleading. In other cases the diagnosis is established by gastroscopy or laparotomy. Such conditions as gastritis, carcinoma of the stomach, tabetic crises, chronic appendicitis, chronic cholecystitis and gastric neuroses may all cause symptoms closely resembling those of gastric ulcer. Carcinoma should be suspected if the pain is not relieved by a week's strict treatment. Contrast radiology may be carried out in bed, using 4 fl. oz. barium.

Course and Complications. *Acute gastric ulcers*: These usually heal rapidly when the appropriate treatment is carried out, but a second ulcer has been known to form during the first stage of treatment. *Chronic gastric ulcers*: These pursue an intermittent course. They may heal spontaneously, or progress and cause such complications as hæmorrhage, perforation, localised or general peritonitis, gastric stenosis due to pyloric or hour-glass constriction, perigastric abscess or adhesions, or carcinoma. General complications are anæmia and malnutrition.

Prognosis. This is on the whole good. A gastric ulcer rarely proves fatal apart from such complications as perforation, hæmorrhage or malignant change. Efficient medical treatment is improving the ultimate prognosis.

Treatment. In the majority of cases the patient requires a preliminary 4 to 6 weeks' course of treatment in bed followed by a prolonged after-treatment. The teeth should be attended to after dental radiograms have been taken, any focus of sepsis being eradicated.

It is now usually agreed that detailed diet sheets are not required in the treatment of peptic ulcer, although the patient who is not in hospital, or those supervising his treatment at home, may ask for a diet sheet. In all cases a list of foods allowed and forbidden should be given.

The most important points in treatment are rest in bed, no smoking, no alcohol, alkalis, small meals with something to eat or drink between meals so that the stomach receives food every two hours by day. A night feed of milk, kept warm in a thermos, should be taken if the patient wakes.

Anticholinergic drugs, such as belladonna, need not be given as a routine, but they may be required for cramping pains. A sedative such as amylobarbitone (Amytal) $\frac{3}{4}$ to $1\frac{1}{2}$ gr. (45 to 90 mg.) may be given daily if the patient is nervous or anxious.

Carbenoxolone (Biogastrone) may assist in the healing of a gastric but not of a duodenal ulcer. It is related to a glycoside in liquorice. The dose is 50 to 100 mg. t.d.s. for 4 to 6 weeks. It should not be given to a patient with heart or kidney disease as it may cause œdema from salt and water retention.

Protein is a good buffer of acidity and can be taken fairly freely. Fat and carbohydrate should be taken in moderation. After meals magnesium trisilicate, a teaspoonful (4 G.) should be taken in water, or a 10% aluminium hydroxide gel (Aludrox), a teaspoonful (4 ml.) in water, with a double dose last thing at night. The mouth should be cleaned after food with sod. bicarbon. 60 gr. (4 G.) in 5 fl. oz. (150 ml.) of water, to prevent parotid infection.

Articles of food allowed: These include:—Milk, bread, butter, toast, rusks, pipless jam, jelly marmalade, honey, plain cake, porridge (fine oatmeal), eggs, boiled or poached, white fish, steamed or boiled, sweet-breads, tender chicken, lamb or beef, mashed or boiled potatoes, sieved or purée of vegetables, steamed puddings, stewed fruits with no pips, skin or core, fruit jellies, souffles, mousses, cream cheese, weak tea, water.

Articles of food forbidden: The following articles of food are forbidden: Smoked salmon, kippers, whitebait, tough meat, pork, high game, sausages, brawn, curry, made-up dishes, fried foods, cheese (except cream cheese), meat extracts and meat soups, pickles, salads, uncooked vegetables, celery, carrots, cucumber, onions or any fibrous vegetables, new or wholemeal bread, buns, Ryvita, Vitawheat, digestive and oatmeal biscuits, hot buttered toast, unripe or raw fruit, rhubarb, plums, nuts, raisins, sultanas, figs, jam with pips, marmalade with peel, strong tea or coffee, aerated drinks and alcohol.

The Medical Treatment of Perforation. Some cases of perforation have been treated successfully without operation. The treatment is applicable in early cases, before the peritoneal cavity is flooded. Morphine $\frac{1}{4}$ gr. (15 mg.) is injected intravenously, repeated if necessary, and a Decicain lozenge, 1 gr. (60 mg.), is sucked. The stomach is emptied with a Senoran's evacuator and a large tube. A small stomach tube is now passed through the nose into the stomach and left there, the stomach being emptied by aspiration with a 20 ml. syringe every half hour. The fluid balance is maintained by rectal, subcutaneous or intravenous injection of normal saline. During the second 24 hours aspirations are made hourly, followed by drinks of 1 fl. oz. (30 ml.) of water. On the third day milk and water are given by mouth, and the tube removed when the fluid output equals the intake, showing that the fluid is not collecting in the stomach. Subsequent treatment is as for acute peptic ulcer.

The Indications for Surgical Treatment. These are as follows: Perforation. Organic pyloric stenosis or hour-glass constriction which impedes stomach emptying. Perigastric abscess. Intractable hæmorrhage due to a perforated, sclerosed artery, which will not repair by coagulation. A suspicion of carcinoma as aroused by the severity of the pain, loss of weight, the persistence of blood in the fæces, and the progressive fall in the free hydrochloric acid in the fractional test meal. Repeated hæmorrhages not responding to medical treatment or recurrent gastric ulcers may also require operation. Partial gastrectomy or vagotomy with gastro-jejunostomy may be performed. The latter may lead to diarrhoea, the sequelæ of the former are described on p. 43.

The Medical Treatment of Severe Hæmatemesis. The patient should be put to bed, and, providing the hæmatemesis is not due to cirrhosis of the liver, a subcutaneous injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) and atropin. sulph. 1/100 gr. (0.6 mg.) given. This may be repeated up to a total of 1 gr. (60 mg.) morphine in the 24 hours. In very severe cases nothing must be swallowed by mouth until the bleeding has stopped, as judged by the absence of hæmatemesis or melenæ. The mouth may be washed out with a little cold water. An hourly pulse chart should be kept. The blood pressure and hæmoglobin

percentage should be determined every 12 to 24 hours. The blood urea should be estimated, and, if raised, determinations should be made daily until it falls to normal. The bowels should not be opened for 4 to 7 days, an enema then being given. Rectal injections of 4 to 8 fl. oz. (120 to 240 ml.) of normal saline containing 5% dextrose should be given every 4 to 6 hours, or a rectal drip may be used with a Murphy vulcanite rectal nozzle, which allows free escape of flatus. Six to 8 pints (3.6 to 4.8 litres) of normal saline (0.85% sodium chloride) and isotonic dextrose (5%) should be run in slowly every 24 hours, resting the bowel every other hour by interrupting the flow. Blood transfusion is required if the hæmoglobin is below 40% (5.9 G. Hb.%), the systolic blood pressure below 90 mm. Hg., the pulse rate over 140, or the blood urea over 100 mg. per 100 ml. One pint (600 ml.) of blood will increase the hæmoglobin by about 10%, (1.3 G. Hb.%) and it should be raised to about 80% (11.9 G. Hb.%). By the drip method a 10% increase in hæmoglobin should be achieved every 4 hours. If there is a history of previous severe hæmorrhages, or if there is arteriosclerosis and the bleeding persists, an operation will probably be required. This should not be delayed until the patient is exsanguine, and a preliminary blood transfusion should be given before the operation. After 2 to 4 days, and when the bleeding has been arrested, as judged by absence of hæmatemesis and by the general condition of the patient, 4 fl. oz. (120 ml.) of half-strength normal saline (0.42% sodium chloride) should be given by mouth every 4 hours for 24 hours. Milk feeds are now begun, first milk 1 fl. oz. (30 ml.), water 1 fl. oz. (30 ml.) and *emuls. mag. oxid.* 30 m. (2 ml.), every 2 hours and then milk 2 fl. oz. (60 ml.) every 2 hours, gradually increased to 5 fl. oz. (150 ml.) every 2 hours. *Tnc. belladon.* 10 to 15 m. (0.6 to 1 ml.) is given before 3 feeds and olive oil $\frac{1}{2}$ fl. oz. (15 ml.) alternately before 3 other feeds. A teaspoonful (4 G.) of the neutralising powder is given after 5 feeds, and a double dose at night. *Ferri et ammon. cit.* 30 gr. (2 G.) should be given t.i.d. between feeds. The patient should now begin the routine treatment for gastric ulcer.

Gastric cooling is sometimes used in cases of massive gastro-duodenal hæmorrhage. The stomach is washed out with iced isotonic solution, the gastric balloon inserted, and the temperature of the cooling fluid in the balloon is kept at 0° to 10° C. The body temperature is kept above 95° (35° C.) by heated blankets. The treatment is continued until the bleeding appears to have ceased for 24 hours.

Routine Medical Treatment of Hæmatemesis. In the majority of cases of hæmatemesis the patient does better with early feeding than with starvation.

Gastric Diverticula

A diverticulum of the stomach is relatively uncommon. It is usually a congenital abnormality, and in the majority of cases is situated near the cardia on the lesser curvature or posterior wall of the stomach.

Clinical Findings. The patient may complain of epigastric discomfort

or pain, and of recurrent attacks of severe vomiting. Hæmatemesis is rare. The diagnosis is made by X-ray examination.

Treatment. If the symptoms are severe the diverticulum can be resected or invaginated.

Carcinoma of the Stomach

Etiology. The cause is unknown. Most recent statistics tend to show that carcinoma rarely develops from a chronic gastric ulcer. Chronic atrophic gastritis is an important predisposing condition. Carcinoma ventriculi is two to three times as common in the male as in the female sex. It is estimated that 4% of all adults die from it.

Pathology. The following types are described: 1. Scirrhus, a spheroidal celled carcinoma with much fibrous stroma. 2. Medullary or encephaloid, a spheroidal celled carcinoma with little fibrous stroma. 3. Adeno-carcinoma, a columnar celled growth. Dual (kiss) adeno-carcinoma has been described occurring on apposing surfaces of the stomach. In the so-called Krukenberg tumour secondary deposits occur in the ovary. 4. Leather-bottle stomach or *linitis plastica*, a diffuse scirrhus growth. 5. Colloid, the growth tends to spread to the omentum. 6. Malignant degeneration of a peptic ulcer. 7. Squamous celled carcinoma is rarely seen, and then it is at the cardiac end of the stomach.

The growth is most often situated at the pylorus, then on the lesser curvature, near the cardia, on the posterior wall, or diffusely on the anterior wall. Adeno-carcinoma may occur as a stomal growth, following a gastro-enterostomy. Secondary carcinoma of the stomach is rare, the primary lesion usually being in the breast.

Clinical Findings. The patient is often an adult male over the age of 40. He states that he has recently suffered from indigestion, a complaint formerly unknown to him or not noticed for several years. The earliest symptoms are usually abdominal discomfort or pain not definitely related to food and often present at night, followed by anorexia, nausea and, later, pain aggravated by food, heartburn, eructations, flatulence, vomiting which may be very persistent, regurgitation of mucus, general weakness, anæmia, constipation, loss of weight and difficulty in digesting solid food. In carcinoma of the cardia dysphagia is often the presenting symptom. In other cases the early symptoms suggest a duodenal ulcer, but without the typical periods of remission. Recurrent thromboses of veins in the legs may be an early symptom. Hæmatemesis is a rare occurrence, but when present the vomit may show the typical coffee grounds appearance. I have, however, seen cases in which recurrent hæmatemesis was the only localising symptom. The pain later becomes very severe.

On Examination: In early cases nothing abnormal can be found beyond epigastric tenderness. As the disease progresses cachexia becomes noticeable, a palpable tumour due to the growth may be felt in the epigastrium or left hypochondrium, and enlarged lymph nodes may be felt above the left clavicle (Virchow's gland, due to spread along the thoracic duct), in the left axilla, and in the groins. Nodules may be

felt in the abdominal wall around the umbilicus. The liver may be enlarged and irregular due to secondary deposits, and ascites may result from pressure of enlarged lymph nodes in the portal fissure. Rectal examination may reveal secondary deposits on the shelf of Blumer. In any case in which the suspicion of gastric carcinoma arises, the following investigations should be carried out :—Opaque meal : This may show a large filling defect due to the growth protruding into the stomach and giving rise to gastric stenosis, or in early cases it is due to an interference with the normal peristaltic wave at a certain spot in the stomach, as seen on the screen. In all cases the patient should be X-rayed in the Trendelenburg position to show up the fundus of the stomach. Fractional test meal : The typical findings are foul, dark resting stomach contents with some blood and high fermentation acid, but no free hydrochloric acid. Subsequent specimens show achlorhydria (absence of free hydrochloric acid) which is at times histamine-fast, and the fermentation acids remain on the high side. Free hydrochloric acid may be found in 30% of cases. Achlorhydria is probably due to previous gastritis, and not to the growth involving the acid-secreting area. The lactic acid in the stomach contents results from fermentation and is not a specific product of the growth. Malignant cells may be found in the stomach washings. In some cases in which the X-ray diagnosis of carcinoma is doubtful, a definite diagnosis, either positive or negative, can be made by gastroscopy. Occult blood in faeces : A specimen of the faeces should be tested for occult blood. The blood : There is usually severe anaemia which may approximate to the pernicious type, with some megalocytes and an occasional megaloblast, but the colour index is not usually above unity. There is usually a leucocytosis of 12,000 per c.mm. or over. Secondary deposits in bone marrow may cause a leuco-erythroblastic anaemia. The sedimentation of the red cells is not necessarily raised.

Differential Diagnosis. The most important conditions to exclude are : Dyspepsia from other causes, including ulcers of the stomach and duodenum. Authors of text-books are often blamed for only giving a picture of advanced and inoperable carcinoma of the stomach. It should be suspected in all cases of digestive disturbances which do not quickly yield to adequate treatment. In all cases of doubt, full investigations, as described above, should be carried out. Even then in some cases the diagnosis remains uncertain and can only be established by biopsy. *Carcinoma of the stomach does at times occur in young adults*, so it cannot be excluded on the ground of age alone. Pernicious anaemia : A blood and bone marrow examination should exclude pernicious anaemia, in which an achylia gastrica (absence of hydrochloric acid and pepsin) is almost always present. Splenic anaemia : A swelling in the left hypochondrium associated with a hæmatemesis and anaemia may suggest an enlarged spleen, and splenic anaemia. The opaque meal usually serves to differentiate. A gumma of the stomach : The Wassermann reaction will help to exclude this, and if positive the response to vigorous anti-syphilitic treatment affords further confirmatory evidence.

Course and Complications. Death usually occurs within 6 to 12 months from the date of diagnosis, unless early surgical intervention proves successful. Complications include dilatation or rupture of the stomach, gastro-colic fistula, jaundice due to obstruction of the bile or hepatic ducts by secondary deposits, ascites, left pleural effusion and thrombosis of the femoral vein.

Prognosis. This is usually hopeless unless early operation has been performed. Only about 10% survive resection for 5 years or over. Malignancy is greatest in poorly differentiated tumours. Polypoid tumours grow more slowly than do infiltrating ones.

Treatment. If the investigations point to early carcinoma, laparotomy should be performed and the growth removed surgically if possible, or radium may be applied locally. Operation in the presence of clinical evidence of metastases, such as enlarged lymph nodes or liver, is not justifiable except to relieve pyloric obstruction. Deep X-ray treatment does not effect a cure.

Medical treatment consists in:—Diet: The patient should be given what he fancies. If there is gastric obstruction liquids or semi-solids only should be allowed. **Gastric lavage:** In cases of pyloric obstruction which are not operated on, the stomach should be washed out with sodium bicarbonate solution, 60 gr. (4 G.) in 20 fl. oz. (600 ml.), daily or more frequently, using a rubber tube. **Drugs:** These are required for pain. Nепenthe 20 to 30 m. (1.2 to 2 ml.) t.i.d. may be given by mouth combined with aspirin 10 to 15 gr. (0.6 to 1 G.), or chlorpromazine (Largactil) 25 mg. tab. t.i.d. Pethidine hydrochlor. 100 mg., methadone (Physeptone) 10 mg. or phenadoxone (Heptalgin) 10 mg. may be injected intramuscularly two or three times a day. These drugs can also be given in tablet form by mouth, but are not then so efficacious. The tablets contain pethidine hydrochlor. 50 mg., Physeptone 5 mg., and Heptalgin 10 mg. To secure sleep hypodermic injections of morphin. sulph. $\frac{1}{4}$ to 1 gr. (15 to 60 mg.) or Omnopon $\frac{1}{8}$ gr. (20 mg.) are usually required. The anæmia usually improves temporarily with vitamin B₁₂ treatment (as for pernicious anæmia, see p. 526).

Sarcoma of the Stomach

It is stated that about 1% of malignant growths in the stomach are sarcomatous. Growth is rapid. The age incidence is usually between 30 and 40. Clinically the condition can only be distinguished from carcinoma by operation. Secondary metastatic sarcoma may occur in the gastric wall.

Benign Tumours, Cysts, and Foreign Bodies in the Stomach

These include: Polypus (adenomatous tumour), fibroma, myoma, adenomatous cyst, hydatid cyst and hair balls (trichobezoars). In gastric polyposis, the tumours are composed of hypertrophied mucous membrane. The swellings are globular and arranged in rows in the transverse axis of the stomach. The symptoms are usually due to

bleeding, ulceration or obstruction. There may be a history of dyspepsia for several years. Intermittent pyloric obstruction occurs in about 10% of cases. The barium meal shows a typical mottled appearance, those areas not showing the shadow of barium being occupied by the polypi. The barium meal should always be repeated after washing out the stomach, to make sure that the appearances are not caused by food residue.

The treatment of these tumours is surgical.

Tuberculosis of the Stomach

The stomach is very rarely affected by tuberculosis. An ulcer may occur secondary to pulmonary tuberculosis or miliary tubercles may be found in the mucous membrane.

Syphilis of the Stomach

A gumma may cause pyloric obstruction, hour-glass constriction or ulceration. Clinically it simulates peptic ulcer or carcinoma, but the Wassermann reaction and the response to anti-syphilitic treatment establish the diagnosis. Some cases of *linitis plastica* are thought to be syphilitic in origin.

Treatment. The patient should be given a course of anti-syphilitic treatment (see p. 600).

THE INTESTINES

Duodenal Ulcer

Definition. A peptic ulcer in the duodenum.

Etiology. The underlying causes are the same as for gastric ulcer (see p. 34). A duodenal diathesis is credited by some, characterised by a hypertonic, hypersecreting and rapidly emptying stomach. There is a distinct familial incidence. *Predisposing causes*: 1. Sex: This disease is four times as common in men as in women. 2. Age: The usual age period is between 30 and 50 years. 3. Smoking: The effect of this is doubtful, as in a series of over 400 cases, over 80% were non-smokers. 4. Duodenal ulcer appears to be more common in blood group O patients.

Pathology. The ulcer is generally situated within an inch (25 mm.) of the pylorus. Various stages may be found, as with a gastric ulcer. The pain is considered to be due to pylorospasm.

Clinical Findings. The patient is usually a middle-aged male, who gives a history of discomfort, later succeeded by pain in the upper abdomen. The pain occurs periodically, lasting for a week or longer, with intervals of relief for several weeks or months. These relief periods shorten as the disease progresses. The pain is often localised by the finger to a spot in the epigastrium just to the right of the mid-line. It may radiate through to the back, near the inferior angle of the right scapula. The pain is related to food, in that it occurs about 3 or 4 hours after a meal, and tends to wake the patient at about 2 a.m. It is temporarily relieved by taking more food ("hunger-pain") and by alkalis. The patient may say that an attack has followed some

dietetic indiscretion. The appetite is usually good, but the bowels are constipated. In some cases, especially with an acute ulcer, melæna, hæmatemesis or perforation may be the first indication of a duodenal ulcer.

On Examination: The patient generally is not wasted. A tender spot may be found in the epigastrium, in the subcostal plane, about $1\frac{1}{2}$ inches (3.75 cm.) to the right of the mid-line. The upper part of the right rectus muscle is then somewhat on guard. In order to diagnose a duodenal ulcer further tests are essential. They are:—An opaque meal: The stomach is usually of the hypertonic type and empties rapidly. Irregularity of the duodenal cap may be seen, or an ulcer crater in one wall, with a niche due to spasm opposite. If there is pyloric stenosis there is delay in stomach emptying. The fractional test meal: There may be no abnormality, but if the ulcer is at the "hurry" stage, there is a high climbing acid curve, due to pyloric spasm and rapid emptying due to violent gastric contractions. If there is pyloric stenosis the high acidity persists, with delay in stomach emptying. The occult blood test: The fæces usually give a positive occult blood test, if active ulceration is present.

Differential Diagnosis. Many cases of duodenal ulcer are atypical. A gastric and duodenal ulcer may coexist, as demonstrated by X-rays. The symptoms may be those of gastric ulcer, whereas the X-ray examination indicates an ulcer in the duodenum. The duodenal symptoms may be due to duodenitis, or reflex, associated with chronic cholecystitis, appendicitis or renal lesions. The symptoms may be typical of cholecystitis, although the gall-bladder is normal and a duodenal ulcer is present. Duodenal adhesions may cause an X-ray deformity of the duodenal cap.

Course and Complications. There are various possibilities when a duodenal ulcer exists. They are:—Complete recovery without further symptoms, or, in healing, pyloric stenosis may develop with progressive vomiting. Progressive ulceration, with adhesions. Perforation: This may be a minute leak with very localised peritonitis, or a subphrenic abscess or generalised peritonitis may ensue. Hæmorrhage. Chronic pancreatitis is met with in some cases. Duodenal ulcers do not become malignant.

Prognosis. This depends upon early recognition and adequate treatment. There is, however, a tendency to recurrence.

Treatment. The medical treatment is identical with that detailed for gastric ulcer (see p. 36). *Surgical Treatment.* Gastro-enterostomy is necessary for organic stenosis. Gastro-enterostomy alone is contra-indicated when the gastric acidity is high, owing to the risk of subsequent development of anastomotic ulcer. In such cases a gastrectomy of the acid-bearing portion of the stomach should also be performed. Post-gastrectomy syndromes include:—1. Dumping. 2. Little stomach syndrome. 3. Intestinal hurry. 4. Steatorrhœa. 5. Afferent or efferent loop syndrome. Later, patients may develop anæmia, undernutrition, osteoporosis and osteomalacia. An alternative operation is vagotomy combined with pylorotomy.

The Dumping Syndrome

This name is applied to a group of symptoms which may occur after partial gastrectomy or gastro-enterostomy. The more extensive the resection of the stomach the more likely is dumping to occur.

The symptoms begin suddenly, either during or shortly after a meal. They include epigastric fulness, nausea, a generalised unpleasant sensation of warmth, cold sweats on the face, and palpitations. There may also be borborygmi and diarrhoea, severe muscular weakness, drowsiness and syncopal attacks. The epigastric fulness is probably due to distension of the jejunum; rapid absorption of sugar from the duodenum may cause hyperglycaemic shock, and muscular weakness may result from a fall in the blood potassium level. The dextrose tolerance test may show a lag curve and the hyperglycaemic symptoms may be relieved by tolbutamide 0.5 G. tab. once or twice daily a.c.

Duodenal Obstruction

Etiology. *Acute Duodenal Obstruction.* This may occur as part of the mechanism resulting in acute dilatation of the stomach.

Chronic Duodenal Obstruction. This may result from :—

1. Progressive duodenal stenosis, associated with an ulcer.
2. External pressure, due to adhesions to the gall-bladder.
3. Visceroptosis, which may be confined to the duodenum.

Chronic Duodenal Ileus

Etiology. The most common cause is compression of the third part of the duodenum between the superior mesenteric artery and the aorta. Megaduodenum secondary to aganglionosis of Auerbach's plexus is a possible cause.

Clinical Findings. The patient may experience no symptoms, the dilated duodenum being discovered on routine X-ray examination. In other cases there are periodical attacks of illness, characterised by epigastric discomfort, gastric flatulence, which is succeeded in some cases by severe pain in the epigastrium to the right of the mid-line, with vomiting of large quantities of bile-stained fluid. In the intervals between the attacks the patient may feel perfectly well or suffer from malaise and headache. The diagnosis is established by a barium meal. Cholecystitis may occur as a complication.

Treatment. Medical treatment consists in washing out the duodenum with a duodenal tube. Duodenojejunostomy is the most effective treatment.

Duodenal Diverticula

These are occasionally met with. They often cause no symptoms and are discovered on X-ray examination. In some cases persistent symptoms are present, such as epigastric discomfort 1 to 2 hours after food, flatulence, nausea and vomiting. The diverticula occur most often in the second part of the duodenum, on its concave side where the



FIG. 2. DUODENAL DIVERTICULUM ARISING FROM THE CONVEXITY OF THE CURVE.

vessels enter and there is no peritoneal coat (see diverticulitis, p. 46). Less often the diverticulum arises from the convexity of the curve (see Fig. 2).

Carcinoma of the Duodenum

This is a rare disease. It may start near the ampulla of Vater, or extend down the bile duct to the duodenum from a primary growth in the gall-bladder, or invade the duodenum from a carcinoma of the head of the pancreas.

Duodenitis

(Proto-duodenitis)

Definition. Inflammation of the supra-papillary portion of the duodenum.

Etiology. Duodenitis does not form a definite clinical syndrome, but it may occur as an early stage of a duodenal ulcer or of catarrhal jaundice. It may also be associated with a kink at the duodeno-jejunal flexure.

Clinical Findings. The patient may complain of pain in the epigastrium relieved by food.

On Examination: Tenderness may be found over the duodenum.

Treatment. This varies with the associated lesions.

Jejunal and Gastro-jejunal Ulcers

Etiology. Jejunal or gastro-jejunal ulceration (anastomotic ulcer) occurs as a complication of gastro-enterostomy performed for duodenal ulcer in about 1 to 2% of all such operations. It is very rare after a gastro-enterostomy for gastric ulcer. It is met with therefore chiefly in males, the important factor being the hyperchlorhydria.

Pathology. The ulcer is usually single; it may occur at the site of anastomosis (gastro-jejunal) or in the efferent loop of the jejunum (jejunal), usually within an inch (25 mm.) of the anastomosis.

Clinical Findings. The symptoms resemble those of duodenal ulcer. They may appear directly after the operation, or be delayed for as long as 17 years. The pain is usually located to a point just to the left of the umbilicus. Examination under X-rays with an opaque meal demonstrates a tender spot in the jejunum.

Course and Complications. Perforation may occur, with general peritonitis or the formation of a gastro-jejuno-colic fistula. Erosion of an artery may result in severe hæmorrhage.

Prognosis. Jejunal ulcers, if untreated, do not heal spontaneously. There is a tendency for recurrence after medical or surgical treatment.

Treatment. *Prophylactic.* Vagotomy or partial gastrectomy, combined with pylorotomy or gastro-enterostomy, should diminish the incidence of anastomotic ulcer. Gastro-enterostomy is contra-indicated when the gastric acidity is high and the rate of stomach emptying rapid, owing to the risk of formation of an anastomotic ulcer. In patients over the age of 50, who will not adhere strictly to medical treatment, a

short-circuiting operation may be performed, apart from stenosis. This is because the gastric acidity tends to fall after the age of 50.

Curative. A strict course of medical treatment, as for gastric ulcer, should be tried. If this fails, operative treatment consists in excision of the jejunal ulcer and undoing the gastro-enterostomy, providing that the original duodenal ulcer has healed. Partial gastrectomy and vagotomy may also be required.

Gastro-Colic Fistula

Etiology. A gastro-colic fistula may follow the formation of an anastomotic ulcer which has developed after a gastro-enterostomy. In other cases carcinoma of the stomach may spread directly to the colon.

Clinical Findings. The principal symptoms are diarrhoea occurring 2 to 3 hours after food and during the night, with eructations having a faecal odour. *On Examination:* There is usually loss of weight. An excess of fat is generally present in the stools, the fat splitting being normal. Further signs of deficient intestinal absorption are a low blood calcium content and a megaloblastic anaemia. These findings resemble those of sprue, but with gastro-colic fistula there is generally hyperchlorhydria and in sprue hypochlorhydria. The diagnosis is best confirmed by a barium enema.

Treatment. This is surgical for cases due to gastric ulcer, but for those due to malignant disease only symptomatic treatment is available.

Intestinal Diverticula

Definition. Pouches in the intestine.

Etiology. This is unknown. Diverticula occurring in the small intestine may in some instances have a congenital origin, but usually they are only recognisable in adult life. Meckel's diverticulum is a congenital abnormality of the ileum. Diverticula are slightly more common in males; they occur especially after the age of 40, but are not notably associated with obesity.

Pathology. A congenital diverticulum carries with it all the coats of the intestine. The acquired variety herniates through the muscular coat, and consists of the mucous membrane and the serous layer; an outer fibrous coat may form. In the large intestine the diverticula are often extruded into the appendices epiploicae, so that they are not visible externally until the fat is removed. They then appear as bluish-black sacs, the colour being due to the faecal contents showing through their thin wall. Their necks may be constricted so that the contents cannot escape. In the intestine diverticula are found occasionally in the duodenum, rarely in the jejunum and ileum, and commonly in the large intestine. They are most often present in the pelvic and descending colon, very rarely in the ascending colon, but they may occur in the appendix and rectum. They are usually multiple in the large intestine.

Three stages are described in their formation: 1. A prediverticular stage. There is localised weakening of the mucous membrane and

hypertrophy of the circular muscle of the intestine. 2. Diverticulosis. Here developed diverticula are present, but they are not inflamed. 3. Diverticulitis. Inflammation is present in the neck of the diverticulum and in the neighbouring intestine. The lumen of the neck is usually obstructed with faeces.

Clinical Findings. A history of constipation is only obtained in about half the cases.

In the prediverticular stage there are usually no symptoms unless constipation is present. X-ray examination with an opaque meal or enema shows an area localised to one part of the intestinal wall, where the normal haustra are replaced by a series of convex irregularities. These areas may be tender on palpation at the X-ray examination. *With diverticulosis* there may be no symptoms, or such symptoms as frequency of micturition, pain in the left lower abdomen, intestinal flatulence, diarrhoea or constipation, and discomfort after defaecation may be complained of. Abdominal examination yields no information. X-ray films show the established diverticula, which may remain filled after the intestine has emptied (see Fig. 3). *When diverticulitis is present* the symptoms are more definite; there may be periodical attacks of fever, with leucocytosis and abdominal pain, usually in the left lower abdomen. The occult blood test on the faeces may be strongly positive.

A sausage-like tumour may be palpable in this site. The bowels never feel to be properly emptied; frequency of micturition may occur especially after defaecation. The opaque meal or enema reveals the characteristic appearances. The affected portion of intestine is fixed and thickened and spikes may project from the wall like a pallisade. These do not alter in position in serial films although the intestine above and below may contract forcibly. In about 70% of cases of diverticulitis arthritis of the lumbar vertebræ is found by X-rays, and there may be severe pain in the back.

Differential Diagnosis. Diverticulitis may be mistaken for left-sided appendicitis, actinomycosis of the intestine, salpingitis or carcinoma. The diagnosis can only be made by a competent radiologist.

Course and Complications. The course is usually slowly progressive. Complications include: "Pistol-shot" perforation in which a stercolith is suddenly forced through the diverticulum. Inflammatory perforation, with localised or generalised peritonitis. Intestinal obstruction. Vesical fistula, air and faeces appearing in the urine. Vaginal or colic fistulae. Carcinoma is a very rare sequela.

Prognosis. This is good in diverticulosis and the early stages of diverticulitis, providing adequate treatment is given. Death may occur from perforation, obstruction or fistula formation.

Treatment. In the acute attacks of diverticulitis the patient should be put to bed, rectal injections of 4 to 6 fl. oz. (120 to 180 ml.) of warm olive oil are given at night, and a saline colonic washout of 1 to 2 pints (0.6 to 1.2 litre) of normal saline in the morning. The washout is given as follows: The saline is warmed to 102° F. (38.9° C.) and run in through a funnel and No. 10 soft rubber catheter. The catheter is injected for 2 to 3 inches (5 to 7.5 cm.) into the rectum, with the patient

lying in the left lateral position. The funnel is held 12 inches (80 cm.) above the anus. The fluid is run in slowly, the patient taking deep breaths. The patient is then assisted into the knee-elbow position and after a few minutes lies in the right lateral position. He should retain the fluid as long as possible. For lesser degrees of diverticulitis and for diverticulosis or the prediverticular stage, treatment consists in colonic washouts with saline, as above, every other day for several weeks, and later twice a week for several months. These must be adequately given to run round all the colon. A low residue diet, as for ulcerative colitis, should be used and all irritant articles of food avoided. Liquid paraffin in doses of 120 m. (8 ml.) twice or three times a day after meals, or I-so-Gel granules, two teaspoonfuls (8 G.) twice a day with meals, should be given to keep the motions soft. Operation is required for perforation or obstruction.

Regional Ileitis

(*Crohn's Disease. Regional Enteritis*)

Definition. A subacute or chronic necrotising and cicatrising inflammation affecting most frequently the terminal ileum.

Etiology. Various causes have been suggested. These include tuberculosis, sarcoidosis, amœbic and bacillary dysentery, foreign bodies in the intestine, the virus of lymphopathia venereum, acute mesenteric lymphadenitis and trauma. None of these suggestions have been substantiated and the cause remains unknown. *Predisposing causes:* 1. Age: The majority of cases occur in the third decade. 2. Sex: Males are affected more frequently than females.

Pathology. There is a non-specific inflammation affecting usually the terminal ileum. There is a progressive granulomatous lymphangitis in the intestinal wall and in the mesentery. The granulomatous tissue may show giant cells, which may cause confusion with tuberculosis and sarcoidosis. The disease may spread upwards to the jejunum, or downwards to the rectum and anus. The wall of the ileum is oedematous and thickened, the lumen is much reduced and the mucous membrane is partially destroyed. Deep ulcers occur between areas of hypertrophied mucous membrane. Fistulae may form between adjacent loops of intestine, into the bladder, into or around the rectum and through the abdominal wall. The latter are becoming much more rare.

Clinical Findings. The disease usually begins insidiously with periodical attacks of diarrhoea and malaise. A perirectal or rectal fistula may be the first complaint. Abdominal pain, usually in the right iliac fossa, is present in about 60% of cases. The pain is often relieved by defaecation.

On Examination: The fingers are clubbed in about 2% of cases. A tender mass may be felt in the right iliac fossa. There is often a low-grade fever. The stools may contain liquid mucus and a little blood, but never pus. Progressive cases show increasing weakness, and psycho-neurotic symptoms may be marked. In some cases the disease has an acute onset resembling that of acute appendicitis. A barium meal shows the characteristic "string sign" of Kantor. This is a thin



FIG. 3. COLONIC DIVERTICULA.



FIG. 4. "SKIP LESIONS" IN REGIONAL ILEITIS.

irregular linear shadow running from the last filled loop of the ileum, through the area of the filling defect to the ileo-cæcal valve. The disease may spread from area to area of the small intestine, leaving normal segments in between. In this way the "skip lesions" and "skipped areas" are produced (see Fig. 4).

Course and Complications. Spontaneous remissions may occur for years, but the course is usually progressive, the remissions becoming shorter. The most important complications are perforation and hæmorrhage.

Differential Diagnosis. A characteristic "string sign" may also be met with in hyperplastic ileo-cæcal tuberculosis, carcinoid of the ileum, endometriosis of the ileum, enterogenous cysts around the ileum, or actinomycosis. It may be mistaken for acute appendicitis.

Prognosis. Spontaneous cure occurs in about 5% of cases.

Treatment. Medical treatment consists in a low residue diet, and the administration of vitamin B₁₂ (cyanocobalamin). Sulphonamides, penicillin and streptomycin have no specific effect. Corticosteroids may be used cautiously for the treatment of diarrhoea, arthritis or erythema nodosum. Potassium loss must be remedied. Surgical treatment offers hope of improvement in perhaps 80% of cases, but recurrence of the disease is very probable. Surgery is necessary in obstruction and with fistula formation.

Appendicitis

Definition. Inflammation of the appendix.

Etiology. The cause is not definitely known. In some cases it may be due to invasion with micro-organisms, such as streptococci and the *E. coli*, rarely with the *Streptothrix actinomyces* or the *Mycobacterium tuberculosis* (*B. tuberculosis*). The organisms enter the appendix from the intestine or from a near-by inflamed organ; in some cases they may be blood-borne as from a distant focus in the tonsils or teeth. Internal mechanical obstruction from hardened faeces (stercoliths or enteroliths), from pips in food or from thread worms, or external obstruction from bands may also lead to appendicitis. *Predisposing causes:* 1. Age: Chiefly between 10 and 40 years. 2. Sex: Males predominate slightly. 3. Race: Especially common in civilised countries. In some cases a familial incidence can be traced.

Pathology. The appendix is acutely inflamed, with hyperæmia of the mucous membrane and a dull appearance of the peritoneal coat, or it is enlarged and dilated, or the mucous membrane is ulcerated. The appendix may be filled with pus, or it may be gangrenous, or perforated, with local or general peritonitis. In chronic cases it may be distorted and bound down by adhesions, and the lymph nodes at the appendix root and in the ileo-cæcal angle enlarged. In actinomycosis the appendix and cæcum are frequently involved and the disease spreads to the peritoneum, abdominal wall and liver.

Clinical Findings. Acute appendicitis is a surgical complaint, and will not be considered in this book. Chronic appendicitis frequently

causes difficulty in diagnosis. It may follow an acute attack of appendicitis or more often develop insidiously. The patient complains of periodical attacks of pain in the right lower abdomen or around the umbilicus, of a gripping nature (appendicular colic), and there may be nausea, vomiting, constipation or diarrhoea. In the intervals the patient is usually well. In other instances he suffers from chronic ill-health (appendicular dyspepsia), with such symptoms as recurring nausea, anorexia, constipation, fulness after meals, and pains in various parts of the abdomen. A momentary sharp stabbing pain may be felt in the right iliac region on walking. Frequency of micturition may be noticed if the appendix irritates the bladder. A focus of infection in the appendix may be the causative factor in such lesions as gastric or duodenal ulcer, cholecystitis or infective arthritis.

On Examination: In a well-marked case tenderness can be elicited on firm pressure over McBurney's point (the junction of the outer and middle thirds of a line drawn from the umbilicus to the right anterior superior iliac spine). The pain elicited may be referred to the umbilicus. In other cases this tenderness can only be demonstrated when the appendix is filled with barium and palpated while it is visualised with X-rays. There is often slight rigidity of the right lower rectus muscle. Occasionally the appendix lies in an abnormal situation, such as in the pelvis, when it may be tender on rectal or vaginal examination, or it may be retro-cæcal, or under the right costal margin, or even on the left side of the abdomen, if the viscera are transposed. The temperature is at times slightly raised. In a doubtful case inflation of the large intestine through a rectal tube may cause pain in the appendix region (Bastedo's sign). Ulceration of the mucous membrane of the appendix will account for the presence of occult blood in the faeces.

Differential Diagnosis. Chronic appendicitis must be differentiated from intestinal colic, intestinal angio-neurotic oedema, pyelitis, a gastric or duodenal ulcer, chronic cholecystitis, biliary colic, renal colic, a growth near the cæcum, ileo-cæcal tuberculosis, regional ileitis, chronic salpingitis or oöphoritis, or enlarged lymph nodes (usually tuberculous) in the right iliac fossa. The urine should always be examined microscopically to exclude the presence of organisms. An X-ray examination of the abdomen will help to exclude a stone in the gall-bladder or kidney or calcified abdominal lymph nodes. An opaque meal helps to eliminate the possibility of a gastric or duodenal ulcer, and a tender appendix may be palpated under the screen as mentioned above. If the appendix fills with barium, it is usually possible to determine whether or not it is fixed by adhesions; if the appendix does not fill, there is evidence that the lumen is occluded, and further ileal or cæcal stasis is suggestive of chronic appendicitis. A cholecystogram helps to exclude cholecystitis. It is often impossible to diagnose ileo-cæcal tuberculosis without an operation, but in some cases pulmonary tuberculosis is also present. A lump may be palpable on abdominal examination, which can be mistaken for carcinoma.

Course and Complications. Chronic appendicitis is characterised by recurrent attacks of pain or dyspepsia; ultimately an attack of

acute appendicitis may develop. In other cases the attacks gradually cease, perhaps owing to permanent obliteration of the lumen. Complications include: Abdominal adhesions, perforation, peritonitis, gastric or duodenal ulceration, cholecystitis and colitis.

Prognosis. This is always uncertain.

Treatment. A chronically inflamed appendix which is causing symptoms should be removed surgically, unless an operation is contra-indicated by some coexistent disease. Appendicular colic may sometimes be relieved by the administration of tnc. belladon 10 to 15 m. (0.6 to 1 ml.) t.d.s. a.c. The treatment of actinomycosis is described on p. 608.

Irritable Colon

(Muco-membranous Colic. Colon Spasm. Muco-membranous Colitis. Mucous Colitis)

Etiology. In many cases irritable colon is considered to be a psychosomatic disease in which, as the result of an anxiety state, there is inco-ordination of colonic movements. In some instances there may be an allergic basis, others follow the prolonged use of cathartics or enemata. In one of my cases it resulted from eating coarse bread. *Predisposing causes:* 1. Age: Usually over 20. 2. Sex: Females predominate. 3. Nervous instability is often present.

Pathology. Often no changes are found post-mortem in the mucous membrane of the colon, but a true inflammatory or granular colitis may be present.

Clinical Findings. The patient is usually a middle-aged woman, who complains of passing mucus in the motions. She is frequently constipated, but there may be periodical attacks of diarrhoea. In some cases there are attacks of constipation followed by abdominal colic, after which mucus is passed. There may also be abdominal discomfort or pain, generally in the left iliac region.

On Examination: The patient is usually, but not invariably, of a nervous type, introspective, with her thoughts concentrated on her motions. She is thin and the tongue is somewhat furred. The descending colon is palpable if it is in spasm or if the patient is constipated, and it may be tender. The motions are usually constipated and the mucus may be passed as long whitish strips, or as a tubular intestinal cast, or in balls. If the rectum is involved there is frequent tenesmus, with passage of mucus. Some blood is at times present in the motions. The motions may also contain yellowish brown granules of intestinal sand, composed of calcium salts of palmitic, stearic and phosphoric acids, with urobilin. There may be a low grade of pyrexia, such as a temperature of 99° to 100° F. (37.2° to 37.8°C.) in the evenings. **Sigmoidoscopy:** An excess of mucus is seen covering the mucous membrane; no ulceration is present, but in some cases the mucous membrane appears inflamed or polypoid.

Differential Diagnosis. Irritable colon has to be differentiated from colitis associated with carcinoma of the colon or diverticulitis and from ulcerative or catarrhal colitis. The diagnosis is established by the

history of the mucus in the stools, the sigmoidoscopic and barium enema findings, the latter showing no evidence of a growth.

Course and Complications. The disease is very chronic, and often is present for many years.

Prognosis. Cure is often difficult to effect, and a relapse is not infrequent after cases have much benefited by a course of rigid treatment.

Treatment. The patient should be put to bed in severe cases, or for the purpose of investigation. The patient's anxieties and fears should be relieved as much as possible by a frank discussion of the nature of the illness. The constipation must be relieved first by rectal injections of 2 to 4 fl. oz. (60 to 120 ml.) of warm olive oil, which are later increased up to 10 fl. oz. (300 ml.). This is retained during the night and followed by an enema of warm normal saline in the morning. Liq. paraffin 60 to 240 m. (4 to 16 ml.), is also given t.i.d. p.c. Intestinal spasm is combated by a mixture containing Tnc. belladon. 5 to 10 m. (0.3 to 0.6 ml.) sod. brom. 5 gr. (0.3 G.), sod. bicarb. 10 gr. (0.6 G.), sp. chlorof. 7 m. (0.45 ml.), aquam ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) t.d.s. a.c.

The diet must not be irritating; no foods leaving residue should be eaten; no salads, skins of fruit or fish, or pips must be taken.

Colitis

Definition. The term colitis includes inflammation and degeneration of the mucous membrane of the colon, and some conditions associated with excessive secretion of mucus. The following varieties are described: Acute catarrhal. Chronic catarrhal. Ulcerative.

Acute Catarrhal Colitis

Etiology. Acute catarrhal colitis may occur as a part of acute gastro-enteritis (see p. 24), sometimes due to an infection with the *Klebsiella pneumoniae* (Friedländer's bacillus), to influenza, or to drugs such as colchicum, or it may be associated with such diseases as typhoid fever, intestinal tuberculosis, dysentery, an intestinal neoplasm, or uramia.

Clinical Findings. The patient complains of diarrhoea, and the stools contain mucus, and at times bright blood. There is usually some abdominal colic and the temperature may be raised.

Treatment. This varies with the cause, and is as described under the diseases with which it is associated.

Chronic Catarrhal Colitis

Etiology. Chronic catarrhal colitis may be a sequela of acute catarrhal colitis, or of dysentery, or it may result from the misguided habitual use of purgatives.

Clinical Findings. The motions are loose, frequent and contain some bright blood and mucus.

Treatment. This again varies with the cause. In general a diet should be taken which is free from irritants (see p. 54). Liquid paraffin 60 m. (4 ml.) should be taken t.d.s. p.c., and if there is pain due

to spasm of the colon, a mixture containing tnc. belladon. 7 to 10 m. (0.45 to 0.6 ml.) t.d.s. a.c. usually affords relief. An abdominal belt should be worn, as the condition is made worse by chill.

Ulcerative Colitis

Definition. A chronic affection of the colon, characterised by ulceration of its mucous membrane. Ulcerations due to dysentery, tuberculosis, syphilis and typhoid fever are not included under this heading.

Etiology. The cause is not known; by some it is believed to be due to dysentery or pseudo-dysentery bacilli or to some undiscovered infective agent. In some cases psychological factors appear to be of importance, and stress has been laid on the dependent personality of the patient. It may be associated with hypersensitivity to food, such as milk, gluten and wheat, or perhaps it is an autoimmune disease.

Pathology. The ulcers are superficial and chiefly situated in the pelvic colon.

Clinical Findings. The patient is usually an adult, who complains of diarrhoea which gradually becomes worse. The onset may be quite sudden without any emotional disturbance, or it may follow a period of worry, or be associated with over-conscientiousness in work. There is often abdominal discomfort or pain, in the left iliac region. If the lesions are low down there is also tenesmus.

On Examination: The patient is usually wasted and anæmic, and there may be a low-grade pyrexia of 99° to 100° F. (37.2° to 37.8 C.) The sedimentation rate of the red cells is usually increased. The stools are loose and contain mucus, bright blood and at times pus. They may occur up to 10 or 20 times in the 24 hours. Sigmoidoscopy reveals a swollen and red mucous membrane, with a mucous exudate; superficial ulcers may be seen, especially on swabbing away the mucus. In advanced stages X-ray examination with a barium enema shows the colon as a rigid, narrow tube, the haustrations usually being absent.

Differential Diagnosis. Ulcerative colitis must be differentiated from a growth in the colon, from mucous colitis, dysentery and pernicious anæmia. If there is a growth, it may be seen with the sigmoidoscope, or if situated higher up, mucus and blood may be seen coming down the colon, the lower part of the mucous membrane appearing healthy. In chronic dysentery the bacilli can usually be isolated from a swab taken from an ulcer, through the sigmoidoscope. The blood count serves to differentiate pernicious anæmia.

Course and Complications. The disease tends to run a very chronic course. Complications include polyposis or stricture of the colon, peritonitis and arthritis which often affect the sacro-iliac joints and the spine. In some cases carcinoma may develop in the colon. The liver may be affected, with pericholangitis, interlobular hepatitis or cirrhosis, and renal amyloidosis may develop.

Prognosis. This is usually grave, prolonged treatment for months or years is necessary to effect arrest of the disease, and even then relapse is liable to occur.

Treatment. The patient should be put to bed, and an enquiry made concerning psychogenic causes. An understanding physician may do much good by tactful reassurance and encouragement. The diet should be of a low residue type. I have found the following suitable :—

Breakfast. Weak tea or coffee with milk. A choice of : Porridge (strained) with milk, crisp toast (well chewed) with butter, egg and lean bacon, white fish (grilled, baked or steamed), pipless jam, jelly marmalade, honey.

Lunch. A choice of : Cream of vegetable soup, lean tender meat, rabbit, chicken, sweetbreads, brains, kidneys, white fish (grilled, baked or steamed), mashed or boiled potatoes, purée of vegetables, milk pudding, fruit purée, jelly, fruit juices, ripe bananas, mild cheese, toast, butter, cream.

Tea. Tea with milk. Crustless bread and butter, spongecake or plain cake, pipless jam, honey or syrup.

Supper. As for lunch.

Sugar may be taken as desired. On waking, at 11 a.m., and last thing at night, milk flavoured as desired.

Articles of food to be avoided : Fried food, pastry, suet pudding, made-up meat or fish dishes, coarse bread or biscuits, strong tea or coffee, raw fruit, salads, pickles, nuts.

Good results have been obtained in some cases of chronic ulcerative colitis by the use of Salazopyrin (sulphasalazine or salicylazosulphapyridine), although the possibility of the occurrence of agranulocytosis, anaemia or allergic reactions must be borne in mind. The drug is put up in 0.5 G. tablets and the average dose for an adult is 2 tabs. three or four times daily with food. A starch and opium enema, starch 60 gr. (4 G.), water 2 fl. oz. (60 ml.), and tnc. opii 80 m. (2 ml.) should be given daily, until the motions are reduced to about four a day. Vitamin B should be administered as Beplex capsules, two daily, and ascorbic acid 50 mg. t.i.d. For the anaemia blood transfusions of 2 pints (1.2 litre) are of the greatest value, and should be repeated until the haemoglobin level reaches 80 to 90% (11.8 to 13.3 G. Hb.%). Iron should then be given in doses of 30 to 60 gr. (2 to 4 G.) t.i.d. of ferri et ammon. cit. providing it does not increase the diarrhoea. In some cases the barium meal reveals marked intestinal hurry, and this is an indication that tincture of belladonna should be given by mouth in doses up to 10 to 15 m. (0.6 to 1 ml.) three or four times a day, with an injection of atropine sulphate 1/75 gr. (0.8 mg.) last thing at night. The dosage must be regulated by the patient's tolerance as judged by the effect on accommodation or the appearance of a rash. Phenobarbitone, ½ gr. (30 mg.), two or three times a day, is also helpful, or codeine ½ gr. (30 mg.) twice daily if there is much pain. In order to endeavour to produce a rapid clinical remission prednisolone may be given by mouth in doses of 10 mg. q.i.d. for 2 to 3 weeks, followed by a maintenance dose of 5 to 15 mg. Unfortunately the effect of the corticosteroids is not permanent. Good results have been obtained by the rectal injection of water-soluble prednisolone. This may be given by the patient each evening for a month as a Predsol retention enema. It is put up in a disposable

plastic bag containing 20 mg. prednisolone in 100 ml. If these measures fail, surgical treatment should be considered. This should not be delayed until the patient is very debilitated. Several varieties of operation have been recommended, but a terminal ileostomy is the operation of choice, and this, in the majority of cases, has to be permanent, the patient wearing an adhesive ileostomy apparatus. This is usually followed by colectomy. The mortality rate for the operation varies between 10 and 20%.

Intussusception

Definition. Telescoping of the intestine. There are two clinical varieties: Acute and chronic.

Acute Intussusception

Etiology. Acute intussusception results from irritation of the intestine and muscular imbalance in its walls. The irritation may be due to hard faeces, worms or a polypus. *Predisposing causes:* 1. Age: Usually infants. 2. Sex: Males predominate.

Pathology. The upper portion of the intestine is invaginated into that below. There are three layers, the inner, entering or intussusceptum, the returning or middle, and the outer, ensheathing or intussusciens. The mesentery enters with the intestine, and compression of the vessels may lead to inflammation, gangrene, or rupture of the intestine. There are four anatomical varieties. 1. The ileo-cæcal. This is the most common, the ileo-cæcal valve and the ileum enter the colon. 2. The enteric. Here one portion of small intestine enters another. 3. The colic. The colon is invaginated. 4. The ileo-colic. The ileum passes through the ileo-cæcal valve, and then the ileum, ileo-cæcal valve and cæcum pass into the colon.

Clinical Findings. The infant is suddenly taken ill with abdominal colic. He may then vomit. The characteristic feature is the loose actions of the bowels; there is tenesmus and passage of odourless mucus and blood.

On Examination: In the ileo-cæcal variety, a "sausage-shaped" tumour may be felt in the upper part of the abdomen or in the left iliac region, whereas the right iliac region feels empty (*signe de Dance*). The temperature falls, but the pulse is frequent.

Differential Diagnosis. Acute intussusception is most likely to be confused with Henoch's purpura (see p. 557). Careful search must be made for purpuric spots in the skin. If found, no operation must be performed. In acute colitis the motions have a faecal odour, and no tumour is palpable. Intestinal polyposis with circumoral spotty pigmentation (Peutz-Jeghers syndrome) may be mistaken for intussusception.

Course and Complications. Collapse and death ensue unless the intussusception is reduced.

Prognosis. This depends upon efficient treatment.

Treatment. This is surgical.

Chronic Intussusception

Etiology. Chronic intussusception occurs in adults, and is usually associated with a simple or malignant growth of the large intestine.

Clinical Findings. The patient suffers from attacks of abdominal colic, with diarrhoea, the passage of blood and mucus, and at times vomiting.

On Examination: A tumour is palpable in the abdomen in some cases, or the invaginated intestine may even protrude from the anus.

Differential Diagnosis. A barium enema may disclose the nature of the trouble.

Course and Complications. The intussusception may unravel itself spontaneously, but usually it tends to recur and, after persisting for several months, results in obstruction or perforation.

Prognosis. The outlook is unfavourable.

Treatment. This is operative.

Intestinal Obstruction

Definition. Obstruction to the passage of faeces through the intestine.

Etiology. The obstruction may be due to: 1. *Causes in the lumen or wall of the bowel.* These include:—A volvulus. An intussusception. A growth. Impacted faeces. A stricture due to syphilis or following dysentery. A foreign body, such as a gall-stone which has ulcerated through into the duodenum (the obstruction then usually occurs in the terminal part of the ileum). Other foreign substances such as masses of thread-worms or a hair-ball. Paralytic ileus, in which there is no mechanical obstruction; this may follow an abdominal operation or complicate acute appendicitis, peritonitis or torsion of the pedicle of the spleen. Regional ileitis (Crohn's disease), in which there is cicatricial stenosis usually of the last 12 to 14 inches (30 to 35 cm.) of the ileum, following a chronic inflammatory condition of unknown origin. Multiple fistulae may be present, communicating either with the large intestine, or tracking through the anterior abdominal wall.

2. *Causes outside the bowel.* Strangulation or obstruction may result from:—1. A band. This may be due to plastic peritonitis or follow a laparotomy. The band may form between two portions of the mesentery, or between the mesentery and an abdominal viscus or inflamed lymph node. 2. A cord. This may pass from the omentum to an abdominal viscus or to the abdominal wall. 3. Meckel's diverticulum may be attached to the umbilicus or to some viscus in the abdomen or to the mesentery. 4. The bowel may be strangulated or obstructed in an internal hernial orifice, in the epiploic foramen (foramen of Winslow) or in a diaphragmatic hernia.

In strangulation the flow of blood through the vessels of the bowel is interfered with, but the passage of faeces is not prevented.

Pathology. The portion of bowel above the obstruction is dilated, the wall is hyperemic and the contents are fluid, consisting of an exudate from the wall and vessels and many bacteria. Histamine may form in the contents, and on absorption give rise to the symptoms of shock.

At the site of the block the intestine is also distended, its coat becomes purplish in colour, and it may be gangrenous and sloughing, with the vessels thrombosed. It usually contains blood-stained fluid and gas. Below the obstruction the bowel is empty, contracted and pale. Peritonitis may occur around the site of the obstruction. The obstruction may occur acutely, as with a band, volvulus, intussusception or incarceration in a hernial orifice, or more gradually, as with a growth in the large intestine, where hardened faeces may prove the last factor producing a total block. The "faecal" vomiting is probably not due to antiperistalsis and regurgitation of faeces, but to an increased exudate into the bowel, the fluid contents well up to the stomach, and are vomited without effort.

Clinical Findings. With acute obstruction the patient is suddenly taken ill with severe tearing and colicky pains in the abdomen, which double him up; he becomes prostrated and collapsed. Vomiting sets in and there is great thirst. The vomit at first consists of the gastric contents, later of bile, and finally it is of the faecal "regurgitant" type. A motion may be passed early in the attack, but after this no faeces or flatus escape from the rectum.

On Examination: The patient is seen to be very ill; he is pale, the skin is moist, the tongue furred and later dry, the temperature is sub-normal, and the pulse frequent. The abdomen is generally distended, but it is not always tender. A tumour may be felt, as with a volvulus, or visible peristalsis may occur from time to time. The higher up in the intestine that the obstruction occurs the more acute are the symptoms. The blood urea and non-protein nitrogen figures are raised. In chronic obstruction the onset is more gradual, and diarrhoea may at first alternate with constipation, then absolute constipation with symptoms of obstruction sets in. The patient should be given a turpentine enema turpentine $\frac{1}{2}$ fl. oz. (15 ml.) and soap and water 10 fl. oz. (300 ml.). This is returned clear, without any force and without the passage of flatus in the presence of obstruction. A direct X-ray of the abdomen will show excess gas in the large intestine if it is obstructed. Similarly gas in the small intestine is a sign of obstruction there; in some cases fluid levels are seen.

Differential Diagnosis. Intestinal obstruction must be diagnosed from other acute abdominal lesions, such as a perforated gastric or duodenal ulcer, acute appendicitis, mesenteric thrombosis, and acute pancreatitis, and from such conditions as biliary or renal colic, lead colic and abdominal crises in tabes. The hernial orifices should be examined. The history of the case, the results of the clinical examination and the inability of the patient to pass faeces or flatus usually enable the diagnosis to be established, before the stage of faecal vomiting is reached.

Course and Complications. Unless relieved surgically, intestinal obstruction is usually permanent. Complications such as perforation and peritonitis may occur.

Prognosis. Death occurs in a few days, unless the obstruction is relieved.

Treatment. An operation should be performed without delay to relieve the obstruction if it is not paralytic in origin. Morphine should

not be given until the diagnosis has been made. For paralytic ileus stimulant treatment is first applied. One ml. of Pituitrin is injected intramuscularly followed in about a quarter of an hour by a glycerin enema, glycerin and water, of each $\frac{1}{2}$ fl. oz. (15 ml.). If no flatus is passed further stimulant treatment should be applied, such as the intramuscular injection of a mixture of acetylcholine 0.2 G., Pituitrin 0.5 ml. and physostigmine salicylate $\frac{1}{64}$ gr. (1 mg.), every hour for four doses. This is followed by an enema of ox bile 2 fl. oz. (60 ml.) and normal saline, 4 fl. oz. (120 ml.), a simple enema being given half an hour later. If this fails, it is best to abandon stimulant treatment and inject subcutaneously morphin. sulph. $\frac{1}{8}$ gr. (10 mg.), apply heat to the abdomen by means of an electric cradle, and give an intravenous drip injection of 1 pint (600 ml.) of normal saline containing 5% dextrose. The electrolytic balance of the body fluids should be maintained, the amount of sodium, potassium, calcium or bicarbonate required being determined by blood estimations. To relieve vomiting a Ryle's stomach tube should be passed and suction applied, either by a syringe or by attaching the tube to an inverted bottle containing water, suspended above the patient, whereby syphonage can be established. Acute distension of small intestine can be relieved by a Miller-Abbott double lumen tube with an inflatable rubber balloon situated near to the perforated metal tip.

Intestinal New Growths

Etiology. The cause of new growths is not known. Carcinoma is usually a disease of adult life, being very uncommon in infants and children. The sexes are equally affected. **Varieties:** An intestinal tumour may be simple, such as an adenoma, polypus, myoma, lipoma or hæmangioma, or more commonly a malignant tumour such as a carcinoma. Sarcoma is rare.

Pathology. Polypi may be multiple, occurring in the large intestine. Diffuse polyposis of the colon of the hereditary type differs from post-inflammatory polyposis. Malignant degeneration almost invariably occurs in the former if the patient lives long enough. Hæmangiomata also may be multiple. Carcinoma is found in the large intestine, in the following sites, in order of frequency: The rectum, pelvic colon, cæcum, transverse colon, splenic flexure, ascending colon, hepatic flexure and descending colon. It is rarely met with in the appendix and small intestine. Secondary deposits occur comparatively late in the disease.

Clinical Findings. Hæmangioma of the small intestine may give rise to recurrent attacks of melæna, with severe anæmia but usually no pain. The patient suffering from a malignant growth is usually an adult over the age of 40. The first symptom may be the onset of persistent constipation or of periodical attacks of diarrhœa, or of alternating constipation and diarrhœa, where the bowels previously have acted very regularly. The patient may also notice abdominal discomfort or fullness, a feeling of general illness, and loss of weight. The appetite may remain good. He may complain of bleeding from the rectum or of a frequent desire to go to stool, if the growth is low down in the rectum.

On Examination : In the early stages often no localising signs can be found ; as the growth enlarges it may become palpable on abdominal or rectal examination. Some pallor and cachexia may also be apparent. There may be slight and irregular fever. The motions may contain macroscopic or occult blood, and mucus or pus. In some cases ribbon-shaped motions are passed, due either to compression by the growth or to reflex anal spasm. With the sigmoidoscope the lower 10 inches (25 cm.) of the alimentary tract can be inspected, and this examination should never be omitted in a doubtful case. A barium enema is more likely to reveal a growth in the large intestine, than is a barium meal. In more advanced cases evidence of secondary deposits may be found in other organs, such as the liver, and there may be ascites.

One of my patients had three rigors with high fever and no bowel disturbance. A tender mass could be felt in the left side of the abdomen and a barium enema showed an annular constriction of the descending colon with a minute perforation. This was found at operation to be a mesenteric abscess secondary to carcinoma of the colon, and they were successfully removed.

Differential Diagnosis. Hæmangioma is not often diagnosed, even at laparotomy. It should always be borne in mind in cases of recurrent melæna and anæmia. Telangiectases may be seen in the serous coat of the affected part of the intestine. The diagnosis of an intestinal malignant growth depends upon the combined results of a manual examination, sigmoidoscopy, the barium enema and the occult blood test. Other conditions which require exclusion are : Hæmorrhoids, simple constipation, redundant loops of the colon, colitis, diverticulitis, actinomycosis, Crohn's disease, a chronic appendix abscess, a gastric neoplasm, enlargement of the spleen, enlargement of the gall-bladder or kidney, hyperplastic tuberculosis of the cæcum, tuberculous peritonitis, and ascites due to other causes.

Course and Complications. The course is slowly progressive ; secondary deposits occur in the abdominal lymph nodes, peritoneum, and other organs, such as the liver and brain. Intestinal obstruction or perforation may occur as complications.

Prognosis. This is fatal, unless the growth can be removed before metastases have formed. Death usually occurs in 1 to 2 years from the appearance of symptoms.

Treatment. In cases of hæmangioma the affected portion of the intestine should be resected. Simple tumours may be removed surgically and malignant ones either treated by operation or by radiotherapy. A colostomy may be required as a palliative measure to relieve obstruction.

Pneumatosis Cystoides Intestinalis

Cysts containing gas form in the wall of the jejunum, colon, rectum and less often in the stomach. John Hunter described the condition in a pig in 1837. The cysts may be subserous or submucous and may be associated with a peptic ulcer. In some cases there are no symptoms, in others there are abdominal pain, flatulence, a mucous discharge from the rectum, frothy diarrhœa, much flatus, bright blood from the rectum, and constipation at times or vomiting. Sigmoidoscopy may show clear

bullæ with frothy mucus. Pneumoperitoneum may occur as a complication. The diagnosis is made by X-ray examination, either plain films or after a barium meal or enema (see Fig. 5). In a patient whom I saw, there was also cystic disease of the lung.

Intestinal Argentaffin Carcinoma

(*Malignant Carcinoid of Intestine. Carcinoidosis*)

Definition. A carcinoma, the granules of the cells having an affinity for silver salts.

Pathology. Malignant carcinoid tumours usually arise in the ileum. Secondary deposits occur in the liver, skin, kidneys, adrenals, lungs and brain. A substance, 5-hydroxytryptamine (5-HT), also known as serotonin, is produced in the argentaffin cells of the tumour and the secondary deposits. It is liberated in the blood and some is taken up by the platelets. The spleen is particularly rich in it. 5-HT is probably a hormone and is normally produced in the argentaffin cells of the gastrointestinal mucosa. It causes contraction of plain muscle, but when injected into an animal it produces vasodilatation. It has also an anti-uretic effect. It is inactivated in its passage through the lungs, and is excreted in the urine as a breakdown product, 5-hydroxyindole acetic acid (5-H.I.A.A.).

Carcinoid tumours may also arise in the bronchus, stomach and pancreas, some of which secrete 5-HT. It appears that serotonin does not cause flushing in these patients, the flushes may be due to a kinin peptide.

Clinical Findings. When a large amount of 5-HT is being produced, especially when there are hepatic metastases, the patient exhibits a peculiar syndrome characterised by cyanosis, attacks of flushing, dyspnoea and diarrhoea. In addition there may be evidence, as shown by X-rays, of a lesion in the intestine, with an enlarged liver and ascites. The tumour may cause abdominal pain or symptoms of obstruction. Another peculiar feature of the syndrome is the presence of pulmonary stenosis, and there may be tricuspid regurgitation. Nodules may be present in the skin.

Differential Diagnosis. This may be established by microscopical examination of a nodule in the skin and by finding an increased excretion of 5-H.I.A.A. in the urine. Mistakes may be made in diagnosing the condition as asthma, right-sided heart failure, cirrhosis of the liver, sprue, or dysentery, or the flushes may be considered to be due to the menopause.

Treatment. As the tumour grows slowly, resection of the primary growth, even if secondary deposits are present, may be worth while.

Hirschsprung's Disease

(*Congenital Idiopathic Dilatation of the Colon. Megacolon*)

Definition. Dilatation and hypertrophy of the colon arising without obvious organic obstruction.

Etiology. It is considered to be a congenital anomaly of the pelvic parasympathetic system, due to absence of ganglion cells in Auerbach's

plexus in a variable portion of the distal colon. This results in failure of normal peristalsis to pass along the affected portion of intestine, with dilatation of the colon above. The cases which manifest themselves in adult life (megacolon) may have a similar origin, but are aggravated by constipation. Some cases occur in association with steatorrhœa. The disease is more common in males than in females.

Pathology. The descending and pelvic colon are chiefly affected, but the rectum is involved in megacolon. The colon is much enlarged and may measure 12 inches (30 cm.) in diameter; the circular and longitudinal muscular coats are hypertrophied and stercoral ulceration of the mucous membrane may be seen. In a severe case the contents of the colon may weigh over 3 stones (19·5 kg.). In Hirschsprung's disease there is a narrow terminal segment of aganglionic intestine in the rectum and rectosigmoid area, with dilated colon above it. In acquired megacolon (pseudo-Hirschsprung's disease) the dilatation of the colon extends down to the anal region. In Hirschsprung's disease the parasympathetic ganglion cells are completely absent in the narrow segment of the colon.

Clinical Findings. The condition may be noticed soon after birth, the infant being extremely constipated and the abdomen becoming distended. In other cases the distension is not apparent until adult life. The patient further complains of ill-health, occasional vomiting, abdominal colic, and some dyspnoea from upward displacement of the diaphragm. The bowels may not be opened for several months, but attacks of diarrhœa sometimes occur.

On Examination : The abdomen may present a ballooned appearance, being either diffusely distended or more so on the left side. Visible peristalsis may be present. Digital examination shows the rectum loaded with fæces in acquired megacolon, and there is often some anal abnormality, such as a painful fissure or congenital narrowing. In Hirschsprung's disease the anal canal is normal and the rectum is empty of fæces. A barium enema may reveal an enormously distended colon, and a narrowed distal segment in Hirschsprung's disease.

Differential Diagnosis. Other causes of severe chronic constipation must be excluded, such as a stricture or a growth. Usually there is no difficulty in establishing the correct diagnosis.

Course and Complications. The course is progressive unless relieved by treatment. Complications include perforation of the colon, volvulus or complete intestinal obstruction.

Prognosis. Children thus affected do not usually survive to adult life, if untreated. Death may occur from obstruction, perforation, starvation or intercurrent infection.

Treatment. An attempt should be made to relieve the constipation by enemata; if the rectum is involved it may be emptied digitally or with an instrument such as a spoon, and the anal sphincter dilated daily by a conical bougie. The colon should then be washed out daily. Spinal anaesthesia, effective up to the 5th Th. root, may immediately result in the bowels being opened. This treatment may be repeated in a few weeks. This is often successful in mild cases of Hirschsprung's disease.

In severe cases, with a long and narrow distal segment, good results may be obtained by excision of all the aganglionic portion of colon, as shown by frozen sections at the operation, the proximal bowel being joined to the anus, with preservation of the sphincter. The operation is preceded first by bowel washouts and then by a right-sided colostomy. Finally the colostomy is closed.

Steatorrhœa

The passage of loose, pale, fatty stools may be due to disease or disorder of the pancreas, the liver, or the intestines.

Pancreatic Steatorrhœa. This may result from chronic pancreatitis, fibrocystic disease, pancreatic calculi or disturbance of function due to hypoproteinæmia caused by malnutrition. The diminished secretion of pancreatic enzymes causes delayed absorption of carbohydrates, proteins and fats from the intestine. Duodenal intubation shows diminution or absence of pancreatic ferments.

Hepatic Steatorrhœa. This is due to an absence or diminished amount of bile salts in the intestine. The stools are usually well formed, but very fatty.

Intestinal Steatorrhœa. Grossly abnormal changes may be present such as regional ileitis, Whipple's disease, tuberculosis, and scleroderma. A blind loop in the intestine, following a short-circuit operation, may result in severe ill health and steatorrhœa, possibly owing to alteration in the intestinal flora. Gastro-colic fistula also causes steatorrhœa, and it may result from gastro-enterostomy.

Whipple's disease, or intestinal lipodystrophy, is characterised by abdominal discomfort, fatty diarrhœa, loss of weight, and in some cases arthralgia, brown pigmentation of the skin and buccal mucous membrane, with low blood pressure. At autopsy the intestinal villi are found to be filled with fat, and foaming macrophages, containing glycoprotein, are present in the mesenteric lymph node sinuses. Tetracycline, 1 G. b.i.d. for several weeks may help considerably.

Idiopathic Steatorrhœa. Under this heading are included certain conditions, such as adult cœliac disease, tropical sprue, and non-tropical sprue, resulting in diminished absorption from the intestine without any gross structural lesions being present. In some cases a rapid intestinal transit time, the barium meal reaching the rectum in two hours, will cause a fatty diarrhœa.

Cœliac Disease

(*Gee's Disease. Gee-Herter Disease. Pancreatic Infantilism. Intestinal Infantilism*)

Definition. A disease of infants characterised by difficulty in the assimilation of fat, wasting and retardation of development.

Etiology. It has been shown in Holland and England to be due to wheat gluten in the diet associated with an enzyme deficiency, which detoxifies gluten. It is not known whether all children suffering from cœliac disease are intolerant of gluten. *Predisposing causes:* 1. Artificial feeding. 2. Age: 1 to 5 years. 3. Sex: Girls predominate.

Pathology. There is inability to assimilate fat and carbohydrate. Post-mortem a round-celled infiltration may be found in the intestinal mucous membrane, and in some cases perilobular pancreatic fibrosis.

Clinical Findings. The onset is insidious, the infant fails to gain in weight and is backward in walking, the appetite is poor and there is looseness of the bowels.

On Examination: The child looks younger than its years, the height is less than normal, there is loss of the subcutaneous fat, wasting, especially of the buttocks and limbs, and sexual immaturity. The face is not necessarily thin, but the skin may be pigmented. The abdomen is swollen with a flatulent distention (see Fig. 6). The liver and spleen are not enlarged. The urine is normal. The bowels are opened 4 or 5 times in the 24 hours, the motions being bulky, pale, frothy and offensive. They contain an excess of fat, with an average of about 50% fat (normal 10 to 27%) in the dried faeces, of which the greater part is composed of fatty acids. The mean faecal fat excretion on a diet containing 30 to 60 G. fat daily is in coeliac disease over 4 G. a day. There is malabsorption in the upper part of the small intestine, as shown by the D-xylose excretion test. There is also a deficiency of bile pigment. A non-diarrhoeic type is also described in which all the symptoms are less severe. X-ray examination of the bones shows delay in ossification or rachitic changes. The oral dextrose tolerance curve, and the vitamin A absorption curve are typically flat, and the barium meal shows a clumping of the barium and a loss of the normal feathering appearance and dilatation of the small intestine. The trypsin content of the aspirated duodenal juice is normal. Malabsorption may cause folic acid deficiency.

Differential Diagnosis. The clinical picture is characteristic. Other conditions which require exclusion are: Hirschsprung's disease, tuberculosis of the mesenteric lymph nodes causing obstruction of the lacteals, chronic *Giardia lamblia* infestation, steatorrhoea, sprue and fibrocystic disease of the pancreas. In Hirschsprung's disease constipation has usually been noted shortly after birth; fatty stools may occur with lacteal obstruction; in sprue the appetite is usually good, and the tongue is sore; and in pancreatic steatorrhoea there is no interference with growth, and the faecal fat is chiefly unsplit. In fibrocystic disease of the pancreas cystic or bronchiectatic changes may be found in the lungs, the fingers may be clubbed, and trypsin is absent, or only present in small amounts, in the duodenal contents.

Course and Complications. The course is usually prolonged unless adequately treated. Complications such as rickets, a generalised but slight oedema, tetany or purpura may occur.

Prognosis. There is a tendency to recovery in the course of 2 or 3 years, but death may result from an intercurrent disease. The immediate outlook has been much improved by the introduction of a gluten-free diet. In severe cases remarkable improvement may be obtained in a period of 2 to 3 months. The expectation of normal development as regards height and sexual maturity is always uncertain. Follow-up studies of young adults who had coeliac disease in childhood, show there is a tendency to relapse.

Treatment. The diet must be gluten-free, as gluten inhibits fat absorption in coeliac disease. Wheat flour and rye flour contain gluten. If gluten is removed from wheat flour, wheat starch is well tolerated and there is no need to restrict carbohydrate and fat. In severe cases the initial diet consists of skimmed milk, Prosol 1 drachm (4 G.) of powder in 1 fl. oz. (30 ml.) of water, glucose and banana purée. The diet is increased by adding minced chicken, egg custard, biscuits made from soya flour, butter, sieved vegetables, potatoes, cornflour, etc. Ascorbic acid 25 mg., halibut liver oil 6 drops, and tab. Benerva co. 1 t.i.d. should be given daily. For anæmia iron should be given by mouth or a blood transfusion may be required. It may be necessary to keep the child on a gluten-free diet during the years of growth. If the child is put back on a normal diet, and the growth and weight fall off, the special diet must be given again.

Cœliac Disease in Adults

(Idiopathic Steatorrhœa. Gee's Disease. Non-tropical Sprue. Gee-Thaysen Disease)

Definition. A disease of adults characterised by steatorrhœa and disturbances of calcium and phosphorus metabolism.

Etiology. The cause is unknown. Some patients are intolerant of gluten. There is deficiency of folic acid absorption owing to changes in the jejunal mucous membrane where folic acid is absorbed. Vitamin B₁₂ deficiency may also occur. *Predisposing causes:* 1. Age: Adolescents and adults. 2. Sex: Females predominate slightly.

Pathology. Post-mortem examination shows no characteristic change.

Clinical Findings. A history can often be obtained of diarrhœa or of rickets in infancy. The patient complains of such symptoms as diarrhœa, weakness, skin eruptions, muscular cramps, pains in the bones, or bony deformities, especially knock-knee.

On Examination: The growth is stunted and the abdomen is often protuberant. The patient presents an infantile appearance. Skin lesions may be seen, such as areas of erythema, pigmentation or exfoliative dermatitis, especially on covered portions of the skin. Spontaneous fractures may be found in various bones; genu valgum or varum is common and the bones show osteoporosis. The fingers may show parrot-beak clubbing. In some cases the colon is distended (megacolon). Changes in the small intestine have also been found by X-ray examination, such as obliteration of the markings of the circular folds, distention of the gut and segmentation of the contained barium into clumps. The blood: There is often an anæmia, either hypochromic or megaloblastic in type. The serum calcium is often low, the plasma phosphorus is usually low but may be normal or high, and the alkaline phosphatase content rises with the activity of the bony changes. The blood sugar is often low, and the sugar tolerance curve flat, but this also occurs in 40% of normal people. The stools are either fatty or appear normal to the



FIG. 5. PNEUMATOSIS CYSTOIDES INTESTINALIS. GAS FILLED CYSTS
IN THE SUBMUCOSA OF COLON.



FIG. 6. A CHILD SUFFERING FROM CELIAC DISEASE, AGE 26 MONTHS, WEIGHT 18 LBS. 4 OZS., HEIGHT 30½ INCHES.

naked eye, but chemical examination reveals an excess of fat, 40 to 70%, normal 10 to 27% of dry faeces. The fats are well split. Jejunal mucosa examined by a biopsy tube shows a flat appearance due to absence of villi. Increased muscular irritability may be demonstrated by Chvostek's or Trousseau's sign (see p. 709) or fully developed attacks of tetany may occur. Opacities in the lens are revealed by the slit-lamp in some cases.

Differential Diagnosis. Cutaneous diseases such as psoriasis or exfoliative dermatitis may be diagnosed, without the true nature of the disease being recognised. In other instances tetany is the predominating feature. The clinical findings resemble those of sprue (see p. 743).

Course and Complications. The course is usually progressive unless adequately treated. Intercurrent infections, such as bronchopneumonia, may ensue, or hæmorrhages from mucous membranes, into the skin or joints, or from the genito-urinary tract, due to vitamin K deficiency.

Prognosis. The welfare of the patient can be very materially improved by adequate treatment.

Treatment. The diet must be free from wheat flour and rye flour which contain gluten. A diet such as that described above for coeliac disease in infants is suitable. Calcium should be administered in the form of calcium lactate 40 gr. (2.4 G.) t.i.d. and vitamins A, B₁, B₂, C and D should also be given. Suitable preparations are: Vitamins A and D, Adexolin capsule (liq. vitamin A et D conc.) 3 m. (0.2 ml.), or caps. vitamin A et D (N.F.) 1 t.d.s.; B₁, Benerva tab. (aneurin. hydrochlor. B.P.) 8 mg., 1 daily; B₂, riboflavin tab. 10 mg., 1 daily; and C, Redoxon tab. (ascorbic acid tab.) 50 mg., 1 daily. In tetany calcium should be administered as described on p. 710. Hypochromic anaemia and erythroblastic anaemia should be treated with iron, such as ferri et ammon. cit. 15 to 30 gr. (1 to 2 G.) t.d.s., and megaloblastic anaemia with Marmite, $\frac{1}{2}$ oz. (15 G.), daily or the intramuscular injection of liver. Two ml. of a crude liver extract such as Hepastab or Livadex should be given every other day. This is also thought to aid fat absorption.

Constipation

Definition. Delay in the passage of faeces through the intestines or delay in their evacuation.

Etiology. The following varieties are described: *Intestinal constipation*: There is delay in the passage of the faeces through the intestines, usually in the colon. *Rectal constipation* or *Dyschezia*: Here the intestinal transit time is normal, but the faeces accumulate in the pelvic colon and rectum. "*Greedy colon*": Excessive absorption reduces the bulk of the faeces.

sive fluid loss as in diabetes mellitus or insipidus, from excessive sweating, or from excessive absorption as in "greedy colon."

2. A large bulk of fæces, as in heavy eaters, causing difficulty in propulsion.

3. Weakness of the intestinal wall. This may be congenital, or acquired due to senile changes or to prolonged wasting diseases.

4. Nervous lesions. Peristalsis may be disturbed by reflex inhibition, as in peritonitis, or by emotional central inhibition, or the reflex activity may be lowered owing to chronic inflammation of the intestinal mucous membrane, or lack of stimulus in the food. Irregular contractions causing spastic constipation may result from an irritant in the bowel.

5. Obstruction, as with new growths of the intestine, stercoliths, bands, adhesions, volvulus, intussusception, and accessory loops (redundant colon).

Rectal Constipation or Dyschezia. This may be due to:—

1. Bad habits. An attempt to have the bowels opened is not made daily at some fixed hour, or the desire to defæcate is neglected.

2. Loss of muscle tone. This may result from habitual neglect to the call, or it may be due to a nervous lesion such as transverse myelitis. The perineal muscles may be weakened by childbirth, and the abdominal muscles by lack of exercise.

3. Pain, as that due to a fissure or to piles.

4. Obstruction, from a growth in the rectum, a stricture or a pelvic tumour.

Clinical Findings. Chronic constipation is a common complaint which often causes no symptoms. The bowels may be opened daily, but evacuation is incomplete. In such cases the patient is not aware that he is constipated. Normally the bowel should be emptied up to the splenic flexure. In other cases the individual may not be constipated although the bowels only move every other day. Constipation is sometimes accompanied by vague symptoms of ill-health, such as a muddy complexion, furred tongue, anorexia, headache, lassitude, flatulence, abdominal discomfort or colic. The diagnosis of the type of constipation can only be made with certainty by means of a barium meal. In dyschezia a digital rectal examination reveals the presence of fæces, even directly after the bowels have been opened. Sigmoidoscopy should always be made in a doubtful case to exclude the presence of a growth in the rectum.

Differential Diagnosis. The barium meal will show where the delay occurs; normally the meal should reach the cæcum in $4\frac{1}{2}$ hours, the hepatic flexure in $6\frac{1}{2}$ hours, the splenic flexure in 9 hours, the pelvic colon in 12 hours, and the rectum in 18 hours.

Course and Complications. The course is usually chronic, the constipation tending to become more severe unless adequately treated. Complications such as colitis, stercoral ulceration of the colon, a fissure or hæmorrhoids may ensue.

Prognosis. This must depend upon the cause of the constipation and the possibility of effective treatment.

Treatment. Prophylactic. Regular habits should be encouraged in children and adults. The dietary should be well balanced and contain sufficient fluids.

Curative. Habits: The patient should attempt to have the bowels open every morning after breakfast; in dyschezia a squatting position should be assumed. **Exercise:** General exercises, local abdominal and perineal exercises and abdominal massage are all of value. **Diet:** The diet should include stewed fruit, such as prunes, fresh fruit, dates, nuts, green vegetables, root vegetables, salads, wholemeal bread, porridge, treacle, coffee, and butter, cream or olive oil.

Medicines: For dyschezia the bowels may be emptied at the beginning of the treatment by a glycerin suppository and later by daily saline colonic washouts, using 1 to 1½ pints (600 to 900 ml.) of warm normal saline, run in at a pressure of 18 inches (45 cm.), the volume being gradually reduced (see p. 47). If the fæces are very hard they may be softened by injecting with a syringe 2 to 6 fl. oz. (60 to 180 ml.) of warm olive oil into the rectum at night, to be retained during the night.

Such laxatives as paraffin liq. 60 to 120 m. (4 to 8 ml.) t.d.s. p.c., agar 60 to 240 gr. (4 to 16 G.) t.d.s., Cascara Evacuant, 30 to 90 m. (2 to 6 ml.) at night, Normacol, 1 to 2 heaped teaspoonfuls, Senokot, 1 to 2 teaspoonfuls, or infusion of senna pods, made by standing the pods in cold water for 24 hours, may be used as required. In spastic constipation, tnc. belladon. 10 to 15 m. (0·6 to 1 ml.), or atropin, sulph. 1/200 gr. (0·3 mg.) in 60 m. (4 ml.) of water may be taken 2 or 3 times a day before food.

Diarrhœa

Definition. The passage of loose or watery motions.

Etiology. Diarrhœa may be acute or chronic. It is a symptom of many diverse conditions, and may be due to:—

1. **Nervous Causes.** These result in the rapid transit of fæces through the intestines. The diarrhœa may be produced by emotion, as by an examination, a public speech or a journey in a train in which there is no lavatory accommodation. In lenteric diarrhœa there is an accentuation of the gastro-colic reflex, several loose actions of the bowels occurring after meals. Diarrhœa in Graves' disease may also be due to nervous excitability. Appendicitis may cause a reflex diarrhœa.

2. **Gastric Causes.** Rapid stomach emptying, as in achlorhydria, gastro-colic fistula, and in some cases of gastro-jejunostomy.

3. **Local Intestinal Causes.** These are numerous and include: Irritation of the mucous membrane from foods with much residue, food-poisoning, drugs such as arsenic, toxins excreted in the bowel as in septicæmia, pneumonia, and uræmia; catarrh of the mucous membrane as in the pre-eruptive stage of measles, tuberculosis, typhoid fever, dysentery, cholera, lambliasis, sprue, coeliac disease, summer diarrhœa, a tumour, masses of hard fæces, amyloid degeneration of the intestines, and leukæmic infiltration of the intestines. Cirrhosis of the

liver with portal congestion, passive hyperæmia secondary to heart failure, and colitis of various types.

4. *Mesenteric Causes.* Tabes mesenterica, and obstruction of mesenteric lacteals causing chylous diarrhœa.

5. *Deficiency of Pancreatic or of Biliary Secretion.*

6. *Carbohydrate Fermentation.* Associated with excessive intake of carbohydrate foods, and deficient exercise.

7. *Hypothyroidism.*

8. *Diabetes Mellitus.* Diarrhœa may occur in patients in whom the diabetes is not properly controlled and who suffer from diabetic neuritis. It may be an example of a neuropathy affecting the sympathetic nerves of the colon. The diarrhœa occurs at night and is intermittent.

Clinical Findings. These must vary with the underlying cause. In lenteric diarrhœa the patient is usually of a nervous type, a child or an adult; a formed motion may be passed after breakfast, but during the morning there are several loose motions. There is often great urgency, so that immediate defæcation cannot be restrained. In the afternoon a similar state of affairs recurs. There is usually no diarrhœa during the night. Gastro-colic fistula is described on p. 46. Hypothyroidism can be demonstrated by a B.M.R. determination and other tests. The clinical findings with the other causes of diarrhœa are considered under their respective headings. Prolonged or severe diarrhœa may result in potassium depletion, with muscular weakness. In some cases it is associated with a villous adenoma of the colon, a so-called potassium-secreting tumour.

In all cases of diarrhœa the stools should be examined by naked eye for colour, appearance, presence of mucus, blood, froth, etc., and in the laboratory for the presence of undigested food residue, the fat and bile contents, and the presence of pathological organisms.

Treatment. In cases of diarrhœa due to acute gastro-intestinal disturbances, a bismuth mixture is helpful, such as Bism. carb. 10 gr. (0.6 G.), sod. bicarb. 15 gr. (1 G.), cretæ prep. 5 gr. (0.3 G.), tnc. chlorof. et morphin. 10 m. (0.6 ml.), aquam ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) ex aq. t.d.s. a.c. For diarrhœa due to food poisoning tab. Entero-Vioform, 1 to 2, t.i.d. may be given. In lenteric diarrhœa all food leaving an irritating residue should be avoided; food should not be taken very hot or ice cold. A mixture is given containing Tnc. belladon. 5 to 10 m. (0.3 to 0.6 ml.), sod. brom. 5 gr. (0.3 G.), sp. chlorof. 5 m. (0.3 ml.), aquam ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) t.d.s. a.c. The dose of belladonna is varied according to the result produced. In achlorhydria the use of acid. hydrochlor. dil. 30 to 90 m. (2 to 6 ml.) t.d.s. p.c. in 4 fl. oz. (120 ml.) of water, often checks the diarrhœa. In hypothyroidism, thyroideum $\frac{1}{4}$ to 1 gr. (15 to 60 mg.) daily, will often cure the diarrhœa. The nocturnal diarrhœa of diabetes mellitus is best treated by properly controlling the diabetes by means of diets and insulin. In any case of long-standing diarrhœa associated with anæmia, folic acid therapy is worthy of a trial, 50 mg. being given daily by mouth for 4 to 6 days. In the successful cases reported the response has been rapid. In cases of diarrhœa associated with *Giardia lamblia* infestation mepacrine

100 mg. tab. t.i.d., by mouth, may cause a speedy improvement. It should be given for a week. The treatment of the other forms of diarrhoea is considered under the respective headings of the causative diseases.

Visceroptosis

This is a condition characterised by downward displacement of abdominal viscera. It is more common in women and is associated with various abdominal symptoms such as constipation, intestinal or gastric flatulence, discomfort and fulness after meals, a dragging sensation relieved by lying down, pain in the epigastrium, around the umbilicus or in either iliac or hypochondriac regions. There may also be pain or aching in the lumbar regions or over the sacro-iliac joints, and neurasthenic symptoms.

On standing there is frequently prominence of the lower part of the abdomen, and the kidneys and less often the liver are easily palpable.

A barium meal may show a lengthened stomach, the upper point of attachment remaining fixed; with the small intestines bunched in the pelvis and the transverse colon low.

Treatment. The foot of the bed should be raised 6 to 9 inches (15 to 22.5 cm.) on blocks. Abdominal exercises should be carried out daily to strengthen the muscles. An abdominal support, such as a Curtis belt, may give a feeling of relief when the patient is up, but should be discontinued as soon as the abdominal tone is increased.

Proctalgia Fugax

This is characterised by recurring paroxysms of severe rectal pain occurring chiefly by night. It is most common in males between the ages of 30 and 50. The attacks may last for a few minutes up to half an hour. The patient may be unable to move in bed during the paroxysm, he feels faint, becomes pale and perspires. The condition is usually considered to be a psychoneurosis. No local cause can be found to account for it, but it has been suggested that the pain is due to cramp of a portion of the levator ani muscle. Attacks occasionally occur by day, especially if the patient is overtired.

Treatment. Relief may be obtained in some cases by eating, or by drinking a glass of cold water, by a change of position, by a hot water bottle applied to the anus, or by passing flatus or fæces. Very severe diurnal attacks may be relieved by taking amphetamine sulph. 5 mg. tab. at the onset.

THE PANCREAS

Introductory. Affections of the pancreas may give rise to very diverse clinical and laboratory findings, according to their nature and to the disturbance of pancreatic function. The effects produced may be grouped as follows:—

Disturbances of Internal Secretion. These may be demonstrated by glycosuria, deficiency of insulin results in diabetes mellitus.

Disturbances of External Secretion. Examination of the fæces may show an excess of fat (steatorrhœa). The normal dried fæces contain about 25% of fat and about 5 G. of fat are excreted in the fæces in 24 hours. With pancreatic insufficiency the fat content may rise to 70% or 80%, the greater part of which is composed of neutral fat. The patient must not take any liquid paraffin by mouth for four days before the specimen of fæces is collected. Undigested muscle fibres may also be present (azotorrhœa). The urinary diastase normally measures between 6·6 and 80 units, but in some pancreatic lesions, such as acute hæmorrhagic pancreatitis, it rises to 200 or even 2,000 units per 100 ml. There is a corresponding rise in the serum amylase. Examination of the duodenal contents or of the fæces may show a diminution or absence of trypsin. The normal amount of trypsin in 1 G. of wet fæces is 900 to 1,500 units.

Pressure Symptoms. A tumour of the head of the pancreas may press on the common bile duct and cause obstructive jaundice, or ascites may result from compression of the portal vein.

Nervous Symptoms. Acute pancreatitis may be accompanied by pain in the epigastrium or back, vomiting and shock, due possibly to irritation of the solar plexus.

Acute Pancreatitis

*(Hæmorrhagic, Suppurative and Gangrenous Pancreatitis.
Pancreatic Necrosis)*

Etiology. In many cases it is believed that acute pancreatitis or pancreatic necrosis is due to thrombosis of the pancreatic artery. The view that the condition is due to regurgitation of infected bile along the pancreatic duct is losing favour. Virus pancreatitis is a blood-borne infection which may occur in mumps and occasionally in infectious hepatitis, and it is possible that in some cases other infections are carried to the pancreas in the blood stream. Acute pancreatitis may result from the administration of ACTH or of corticosteroids. *Predisposing causes:* 1. Age: Usually over 40 years. 2. Sex: Males predominate. 3. Gall-stones and infection of the biliary passages. 4. Other diseases: Such as mumps, typhoid fever and small-pox. 5. A bout of drinking.

Pathology. The steapsinogen and trypsinogen of the pancreatic secretion become activated in the gland. This can be effected by bacteria. Further, trauma or hæmorrhage, resulting in a local autolysis of pancreatic tissue, produces an activating substance which converts trypsinogen into trypsin. The pancreas and adjacent peritoneum show varying degrees of change, such as œdema, hæmorrhage, fat necrosis or gangrene. Local suppuration may also occur. Fluid containing blood may be present in the lesser peritoneal sac or in the general peritoneal cavity. Pearly-whitish areas of fat necrosis may be seen in the pancreas, omentum, mesentery and retro-peritoneal fat. The toxæmia results from autolytic substances produced in the gland.

Clinical Findings. The patient is suddenly taken ill with intense pain in the epigastrium and across the lower part of the back of the chest. He feels sick, vomits and collapses.

On Examination: In a severe case the patient is desperately ill, pale, cold, sweating, and at times cyanosed. The epigastrium is extremely tender, and there is some, but not very marked, muscular rigidity in the epigastrium. Bluish mottling of the abdominal wall around the umbilicus may be noted (Cullen's sign). There may be definite tenderness in the left costo-vertebral angle. The patient does not keep still as he does with a perforated gastric ulcer. The abdomen becomes distended, the bowels are confined, but flatus is passed. No intestinal movements can be heard with the stethoscope. The temperature is usually sub-normal unless suppuration or gangrene is present. The pulse is frequent and feeble. The vomit often contains bile. The serum amylase is usually well over 200 units per 100 ml. serum during the first 24 hours, and the urine may contain sugar and acetone bodies. Mild cases also occur in which the diagnosis is established by the amylase test.

Differential Diagnosis. Acute pancreatitis resembles in some respects other acute abdominal emergencies, such as perforated gastric or duodenal ulcer or intestinal obstruction. In perforation of a peptic ulcer a serum amylase figure of about 200 units may be obtained. Coronary disease or acute cholecystitis may be simulated in other cases. The characteristic features of acute pancreatitis are the age of the patient, the frequent history of gall-bladder trouble, the absence of a history pointing to a gastric or duodenal ulcer, the cyanosis, the persistent vomiting, collapse, and, above all, the high serum amylase figure. A high serum amylase reading, up to 1,600 units or more, may be found in renal failure. The blood urea in these cases is also raised.

Course and Complications. If untreated, the course is generally rapidly progressive, the patient being overwhelmed with toxæmia. Suppuration or gangrene may occur as complications, or a pancreatic pseudo-cyst may form in the lesser peritoneal sac. Diabetes mellitus has been recorded developing five years after a successful operation for acute pancreatitis.

Prognosis. This has been improved by modern methods of treatment. Sudden death may be due to acute hæmorrhagic pancreatitis. When mumps is the cause of the disease the prognosis is good, as suppuration and necrosis of the gland do not occur.

Treatment. In mild cases rectal salines containing 5% dextrose, and intramuscular injections of pethidine hydrochlor. 50 to 100 mg. should be given. In more severe cases continuous gastric suction through a nasal tube should be applied to prevent the stomach contents entering the duodenum and stimulating pancreatic secretion. The blood volume and electrolytic balance must be maintained by continuous intravenous drip injections. Pro-Banthine Bromide, 80 mg., injected intramuscularly every 6 hours, may relieve the pain, the drug acting as a sympathetic ganglion blocking agent. Pethidine hydrochlor.

100 mg., may also be injected intramuscularly for pain. Morphine should not be injected. Benzylpenicillin should be injected intramuscularly in doses of 1 million units (600 mg.) every 12 hours. Corticosteroids are contraindicated. Trasyolol, a non-toxic trypsin inhibitor, is of doubtful value. An exploratory laparotomy decreases the patient's chance of survival, but may be indicated if there is doubt whether the condition is one of perforated peptic ulcer. The gall-bladder should also be removed if it appears diseased.

Chronic Pancreatitis

Etiology. Chronic inflammation of the pancreas is usually due to bacterial infection of the pancreatic lymphatics, the organisms being derived from the gall-bladder or the intestine. It may also be secondary to obstruction of the pancreatic duct, as by a gall-stone in the hepato-pancreatic ampulla (ampulla of Vater), a pancreatic calculus, inflammation of the pancreatic ducts or carcinoma of the pancreas. Arteriosclerotic vessels, syphilis or hæmochromatosis are also causative factors.

Pathology. In chronic interstitial pancreatitis the fibrosis may be interlobular, when it is often localised to the head of the gland, or interacinar when it is more diffuse. In chronic catarrhal pancreatitis there is inflammation of the pancreatic ducts.

Clinical Findings. *Chronic interstitial pancreatitis:* The patient is usually an adult who complains of epigastric discomfort or pain, or of aching in the back, flatulence and the passage of bulky, pale and pasty stools. *Chronic catarrhal pancreatitis:* The patient has periodical attacks of nausea, shivering, pain in the epigastrium and the left side of the back, vomiting and diarrhoea with large motions. In chronic relapsing pancreatitis the patient may be completely free from symptoms between the attacks of pain.

On Examination : Epigastric tenderness is present, the conjunctivæ may be slightly icteric, the stools contain an excess of fat and undigested muscle fibres. In some cases the only symptom is a persistent painless jaundice, due to pressure of the head of the pancreas on the common bile duct. The urine may contain bile pigment and glucose, especially in the case of interacinar pancreatitis, and the serum amylase figure may be raised.

Differential Diagnosis. Chronic pancreatitis must be diagnosed from sprue and from digestive disturbances due to biliary insufficiency. In sprue the history of residence abroad, the characteristic tongue and anæmia, and the excess of split fat in the fæces usually serve to establish the diagnosis. With biliary insufficiency there is also excess of split fat in the fæces and diminution of bile pigments and bile salts. The pain may suggest a diagnosis of duodenal ulcer. The laboratory tests are often all negative in cases of chronic relapsing pancreatitis.

Course and Complications. The course extends often over several years, the patient gradually losing weight. The common bile duct may be compressed in the head of the pancreas, with resultant jaundice.

Prognosis. This is unfavourable, as regards complete recovery.

Treatment. A fat-poor diet should be given. Eggs should not be eaten. The following articles are permitted : Toast, thin bread and butter, minced meat, fish such as cod, hake, or haddock, green vegetables, fruit, and salads. The patient should take no alcohol. Pancreatin 30 gr. (2 G.), six 5 gr. (0.3 G.) tablets, may be given t.i.d. after meals. Calomel $\frac{1}{2}$ gr. (30 mg.) should be taken at night and a small dose of salts, mag. sulph. 30 gr. (2 G.), in the morning. If there is cholecystitis or gall-stones cholecystectomy should be performed. The common bile duct may also require surgical drainage. Cholecystenterostomy may be required to relieve jaundice.

Fibrocystic Disease of the Pancreas

(Congenital Pancreatic Deficiency. Fibrosis of Pancreas.

Cystic Fibrosis of Pancreas)

Etiology. The cause is still unknown. It has been suggested that there is a generalised disorder of mucus-secreting glands, a mucosis, the mucus secreted being scanty and excessively viscid. This would mean that in the pancreas the mucus-secreting ductal cells are affected, with secondary pancreatic changes. Other suggestions put forward include a genetically-determined malformation of the duct system, or primary vitamin A deficiency resulting in obstruction of the pancreatic ducts by desquamated epithelial cells and an increased liability to infection in the lungs. Although a serious vitamin A deficiency is usually present, it cannot be considered to be the cause of the disease.

Pathology. The exocrine glands are particularly affected, the pancreas, liver, lungs, sweat and salivary glands being involved. The ducts and acini of the pancreas are dilated and there is atrophy of external secreting tissue. The inter-alveolar cell islets are unaffected. The lungs show areas of suppurative bronchitis, bronchiectasis, and terminal bronchopneumonia or abscess. Areas of focal biliary fibrosis may be found in the liver. Calcium salts may be deposited in the kidneys.

Clinical Findings. The patient is an infant, and three types of disease are described. The baby may die during the first or second week of life on account of meconium ileus, or stenosis or atresia of the intestine. Meconium ileus implies intestinal obstruction in the newborn, due to meconium which is thick and mucilaginous owing to lack of trypsin during intra-uterine life. The intestines may rupture and meconium peritonitis result. In the second group, the symptoms are chiefly pulmonary, cough, cyanosis, clubbing of the fingers, with X-ray findings of bronchiectasis or cystic spaces in the lungs. The third group resembles coeliac disease with large stools, intolerance of fats and carbohydrates, but, in addition, there are signs of bronchitis or bronchiectasis. The trypsin of the duodenal contents or faeces is reduced or absent, and this is an important laboratory test. The faecal fat is over 80% and is well split. The vitamin A absorption curve and the oral dextrose tolerance curve show flat readings. Increased sweating may occur, with excessive sodium loss in hot weather, and there is liability to cramps and heat prostration, or even death. The Shwach-

man sweat test consists in demonstrating an excess of sodium chloride in the sweat. The finger-print method is safe. The print is taken on an agar plate containing silver nitrate and potassium chromate. Salt in the sweat blanches the suspended chromate. The sodium content of nail clippings is usually increased.

Prognosis. Death often occurs before the age of 14 months from pulmonary infection, but I have seen a child in whom the diagnosis was first made at the age of 6 years and who responded well to treatment, and the patient may reach adult life before the diagnosis is first made.

Treatment. If there is bronchiectasis postural drainage should be practised daily and antibiotics such as tetracycline (Achromycin) or streptomycin given for 2 weeks or longer. Pancreatin 30 gr. (2 G.), six 5 gr. (0.3 G.) tablets, should be given with each meal. The diet should be high in protein and low in fat. In addition, halibut liver oil should be given by mouth, 5 to 10 m. (0.3 to 0.6 ml.) twice daily, and vitamin A, 100,000 units, injected intramuscularly every 3 months. Extra salt is required in hot weather.

Tumours of the Pancreas

Simple tumours and gumma are rare; an adenoma of the inter-alveolar cell islets (islets of Langerhans) may give rise to *hyperinsulinism*, with symptoms of spontaneous hypoglycæmia such as faintness, sweating, headache, etc. (see p. 671). Cardiac symptoms predominate in some cases, either anginal in type or resembling the effort syndrome. Neuropsychiatric symptoms may predominate, such as episodes of uninhibited emotional behaviour, cured by removal of an islet tumour. Further, people with cerebral dysrhythmia, as shown by the electroencephalogram, are very susceptible to falls in the blood sugar level. The dextrose tolerance curve, after 3 days on a diet containing 300 G. carbohydrate, shows a low fasting value of about 70 mg./100 ml., a rise to about 120 mg. after 50 G. of dextrose by mouth, and subsequently low readings at 2, 3 and 4 hours. A hypoglycæmic attack may occur during the test. Widespread adenomatosis of the pancreatic islet cells is a rare condition requiring hemipancrcreatectomy. Spontaneous hypoglycæmia may also be due to functional hyperinsulinism and hepatic disease. In functional hyperinsulinism the fasting blood sugar is usually normal, in hepatic disease the fasting blood sugar is low, but the curve shows a high plateau, similar to that in diabetes mellitus. In the latter there is no hyperinsulinism but faulty glycogenesis in the liver. It may occur in such conditions as cholangitis, toxic hepatitis, Von Gierke's disease (see p. 104), diffuse carcinomatosis and fatty degeneration of the liver. Malignant tumours are usually carcinomata; sarcomata are rare. Hyperinsulinism was first described in 1927 in association with a carcinoma arising in the islets of the pancreas.

Carcinoma of the Pancreas

Pathology. The carcinoma is usually primary and situated at the head of the gland. Secondary deposits in the pancreas are less common, the primary growth being usually in the stomach. The gall-bladder may

be enlarged owing to compression of the common bile duct by the growth or by secondary lymph nodes in the portal fissure.

Clinical Findings. The patient is usually a male, over the age of 40. He complains of general weakness, loss of appetite, pain in the epigastrium passing through to the back, progressive jaundice and itching of the skin. In some rare cases the symptoms are those of recurrent hypoglycæmia, in others there are no signs, the patient complaining only of severe pain in the back in the lower dorsal region, or of girdle pains, which are relieved by heat and by sitting bent forward.

On Examination : The patient is wasted, and the skin is jaundiced to a variable degree, sometimes only slightly, but it may be dark green ("black jaundice"). The gall-bladder may be palpable, but the pancreatic tumour can rarely be felt unless it is situated in the body or tail of the gland. The barium meal may show indentations on the medial border of the second part of the duodenum due to pressure by the growth in the head of the pancreas. The urine may contain bile pigment and sugar, the motions may be pale, and contain an excess of split fat.

Differential Diagnosis. It is not generally possible to distinguish a growth in the head of the pancreas from one in the bile ducts. The enlarged gall-bladder, emaciation and progressive jaundice are indicative of growth as opposed to chronic pancreatitis. A barium meal and fractional test meal serve to exclude carcinoma of the stomach.

Course and Complications. The course is rapidly progressive. The growth may erode into the stomach and cause hæmatemesis. Secondary deposits may occur in the long bones with a resultant anæmia. This is usually hypochromic, but at times megalocytic, when nucleated red cells and less often megaloblasts are present. The abdominal and mediastinal lymph nodes may also be invaded, and ascites may develop.

Prognosis. Death usually occurs in the course of a few months.

Treatment. Cholecystenterostomy may be performed to relieve the jaundice and itching, but there is no curative treatment.

Cysts of the Pancreas

Pathology. The following varieties of cysts may occur: 1. The retention cyst: This has an epithelial lining, and forms as the result of obstruction of the pancreatic ducts, as by a stone or chronic pancreatitis. 2. The pseudocyst: This is formed by the lesser peritoneal sac, and results from trauma or acute pancreatitis. 3. The proliferative cyst and cyst-adenoma: These are multilocular and often found near the tail of the pancreas. They may form part of congenital polycystic disease of the kidneys and liver. 4. The hydatid cyst (see p. 764) and dermoid cyst.

Clinical Findings. The patient is usually over the age of 20. There may be a history of abdominal trauma. There may be no symptoms, or the patient may complain of pain in the epigastrium or between the shoulders, and of nausea, vomiting, constipation, jaundice and swelling of the abdomen and legs.

On Examination : The cyst may be felt as a rounded fluctuating

swelling in the epigastrium. It commonly presents between the stomach and transverse colon, but may show above the stomach or below the transverse colon as indicated in the diagram (see Fig. 7). Its position can usually be identified with the help of a barium meal or enema. The cyst fluid, removed by aspiration, may contain pancreatic ferments.

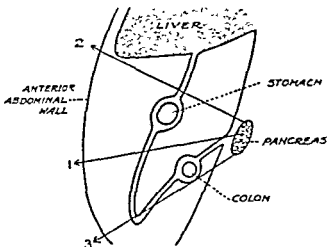


FIG. 7. DIAGRAM SHOWING POSITIONS IN WHICH A PANCREATIC CYST MAY PRESENT.

Differential Diagnosis. The pancreatic cyst may be mistaken for a hydatid cyst of the liver, a mesenteric cyst, a hydronephrosis, or rarely for an ovarian tumour. The anatomical relations usually suggest the correct diagnosis.

Course and Complications. There is usually gradual enlargement of the cyst, but internal hæmorrhage causes rapid distention. Rupture results in local or general peritonitis. Malignant degeneration may occur.

Prognosis. A complete cure, even after operation, is improbable, as recurrence often takes place. Post-operative diabetes mellitus has also been recorded.

Treatment. An exploratory laparotomy usually permits the cyst to be drained, complete removal being generally impossible.

Pancreatic Calculi

Etiology. Calculi form as the result of obstruction of, or infections in, the pancreatic ducts.

Pathology. The calculus may be composed of a mixture of calcium carbonate and phosphate, or of calcium oxalate, carbonate and cholesterol. Calculi are usually multiple, not faceted, and vary in size from a small granule to an inch (25 mm.) in diameter. The pancreas shows chronic inflammatory changes and gall-stones are often present.

Clinical Findings. The patient is usually a male, over the age of 40. There may be no symptoms, or attacks of epigastric colic and vomiting occur, the pain radiating to the region of the left scapula.

On Examination : The patient may be tender in the epigastrium and also jaundiced. The fæces show azotorrhœa or steatorrhœa, and the greyish-white calculi may be passed in the stools. If the calculi are rich in lime, they are shown by X-ray examination.

Differential Diagnosis. The colic resembles biliary colic, but the pain tends to radiate to the left.

Course and Complications. Repeated attacks of colic may occur. Complications include diabetes mellitus, pancreatic abscess and peritonitis. An abscess may discharge through the abdominal wall.

Treatment. Sedatives such as morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) are required, as for biliary colic. In some cases the calculi have been removed by operation.

THE LIVER, GALL-BLADDER AND BILE DUCTS

Introductory. In studying diseases of the liver, certain special methods of investigating hepatic function are available.

The hepatic efficiency tests of most clinical value include : 1. *The investigation of the pigmentary function.* This involves tests for the presence of bile in the blood, urine and fæces. Bile pigments in the blood are shown by the van den Bergh test. The normal amount of serum bilirubin is 0.1 to 0.8 mg./100 ml. The icterus index is a less accurate test, as the serum may be coloured by other substances than bilirubin, such as carotene or mepacrine. The normal value in the blood is 2 to 8 units. In *latent jaundice* there is an excess of bilirubin in the blood, usually between 1 to 3 mg./100 ml., but no jaundice is found clinically. The "direct" (conjugated) and "indirect" (unconjugated) and total serum bilirubin are determined. When the jaundice is mainly due to increase in "direct" pigment the condition may be obstructive, or toxic and infective. Latent jaundice is met with in infectious hepatitis, cirrhosis hepatitis and the hæmolytic anæmias. In *dissociated jaundice* there is an excess of bile salts in the blood without a corresponding rise in the bilirubin content. This may cause pruritus and bradycardia in certain cases of cirrhosis hepatis. Bile pigments in the urine can be tested for clinically. With a deficiency of bile in the intestine the stools become fatty, there being an excess of split fat.

2. *The metabolic function.* In the *galactose tolerance test* 40 G. of galactose are given by mouth and the blood galactose curve determined, and the urine examined for galactose. The blood samples are examined every 30 minutes for 2 hours. Normally the blood galactose does not rise above 10 to 40 mg./100 ml. The sum of the four blood galactose readings, called the galactose index, is normally about 70 mg. An index over 160 indicates hepatocellular damage. Normally the urinary excretion of galactose in 5 hours is less than 3 G. A figure over 4 G. is suspicious, and one of over 6 G. indicates severe liver damage.

3. *The hæmopoietic functions.* The *alkaline plasma phosphatase* rises above the normal of 7 to 13 King-Armstrong units/100 ml. in some cases of obstructive jaundice. It has been claimed that readings above 50 units signify obstructive jaundice, above 20 units indicate non-

obstructive jaundice, and normal figures are found in hepatic jaundice. It must be remembered that the alkaline phosphatase is raised in such conditions as Paget's disease, rickets, hyperparathyroidism, osteomalacia, osteogenic sarcoma and other primary skeletal tumours. The plasma proteins may also be affected in liver disorders, the plasma albumin falling below the normal low level of 3.8 G./100 ml. There are many other causes for a fall in the plasma albumin. Flocculation tests include the colloidal gold, the zinc sulphate and the thymol turbidity. The normal readings are, colloidal gold 0 to 1 unit, zinc sulphate 0 to 6 units, and thymol turbidity 0 to 4 units per ml. The flocculation tests are usually positive in infectious hepatitis and negative in obstructive jaundice. They depend on an increase of γ , or β plus γ -globulins in the plasma.

4. *The excretion of foreign substances.* The bromsulphthalein test consists in the intravenous injection of 5 mg./kg. body weight of bromsulphthalein and removal of a specimen of blood at 5 minutes and 45 minutes. The dye content of the sera is estimated. Normally the 5-minute specimen contains between 15 and 85% of the dye, and the 45-minute specimen between 0 and 5%. A figure above 20% in the second specimen indicates liver damage.

5. *The indications of liver damage.* The serum transaminases may be raised when liver cells are damaged. Serum glutamic pyruvic transaminase (SGP-T) seems to be more indicative of liver damage than is serum glutamic oxalacetic transaminase (SGO-T). The tests can be carried out in the presence of jaundice. The transaminases are raised in cell damage elsewhere, as in coronary thrombosis. The normal SGP-T is 5 to 35, and the normal SGO-T is 8 to 40 units/ml.

6. *The prothrombin response to vitamin K.* This is of value in surgical jaundice. The prothrombin in the blood is estimated (see p. 191). If it is low 100 mg. of vitamin K (Synkavit, 100 mg. in 2 ml.) are injected intramuscularly. The prothrombin is estimated again after 24 to 48 hours. If the value is now normal it indicates biliary obstruction. If there is no response there is probably gross liver damage.

7. *Liver puncture biopsy.* A small specimen of liver tissue is removed by liver puncture, using a special trocar and cannula, and examined histologically.

8. *X-ray examination.* Cholecystography and cholangiography reveal the size, shape, filling capacity and contractility of the gall-bladder, and the presence of calculi and the condition of the bile ducts. In some cases calculi are seen in a direct radiogram.

THE LIVER

Hepatitis

Infectious hepatitis is the most common cause of acute inflammation of the liver. Less often it is associated with hepatic abscess, secondary syphilis, cloudy swelling, acute massive necrosis of the liver and toxins and infections affecting the liver. Cirrhosis of the liver may be regarded as a variety of chronic hepatitis.

Malformations and Displacements

The malformation which is of the greatest importance clinically is the Riedel's lobe. This is a tongue-like downward projection from the right lobe of the liver, which may be mistaken for an enlarged gall-bladder, or for the right kidney. It usually occurs in women.

The liver may be displaced downwards, as by a subphrenic abscess, or upwards by an abdominal tumour or ascites. Hepatoptosis is a term applied to prolapse of the liver. It is more common in women and may give rise to abdominal dragging, to pain, or to biliary colic.

On Examination : An abdominal tumour is felt which can be pushed back into the space normally occupied by the liver.

Hyperæmia

Active Hyperæmia. This may be associated with a chill, especially in tropical countries, in individuals who have suffered from malaria or dysentery. It may also result from over-eating, associated with a sedentary life and chronic constipation. It is often known as a "chill on the liver."

Clinical Findings. The patient complains of headache, nausea, constipation, and a sense of fullness or pain in the region of the liver.

On Examination : The tongue is furred, and the liver may be just palpable and somewhat tender.

Treatment. The patient should be kept in bed for a few days, on a milk diet, and aperients given such as calomel 2 gr. (0.12 G.) nocte, with mag. sulph. 60 to 120 gr. (4 to 8 G.) mane. Hot applications to the liver area are comforting.

Passive Hyperæmia. This usually results from back pressure due to heart failure. There is congestion and anoxia of the central zone of the liver lobules, producing the "nutmeg" liver.

Clinical Findings. The patient may complain of pain in the liver region.

On Examination : In addition to the evidence of cardiac disease, the liver is enlarged and expansile pulsation may be detected on bimanual palpation, especially if tricuspid regurgitation is present. There may also be jaundice.

Treatment. The underlying cardiac lesion must be treated. In addition, venesection helps to relieve the congestion.

Infarction

The intralobular branches of the portal vein may be blocked by an embolus or by thrombosis. An embolus may also occur in the hepatic artery. Thrombosis may develop in the larger branches of the portal or hepatic veins. The embolus may consist of blood clot or of a portion of new growth. The infarct is hæmorrhagic, unless due to obstruction of the hepatic artery, when it is anæmic. It is generally deep-seated and gives rise to no symptoms during life, unless there is pain from an associated perihepatitis.

Perihepatitis

Definition. Inflammation of the capsule of the liver. This may be acute or chronic.

Acute Perihepatitis

Etiology. This may be secondary to a liver abscess, gumma, hydatid cyst, cholangitis, etc., or it may form part of a general or local acute peritonitis.

Clinical Findings. The patient complains of pain in the region of the liver, near the angle of the right scapula, or at the tip of the right shoulder.

On Examination: There is diminished movement on the affected side of the chest, the liver may be tender on palpation and a localised friction rub can be felt or heard.

Treatment. The pain is best relieved by immobilising the side of the chest by strapping.

Chronic Perihepatitis

This may be local or diffuse.

Local Perihepatitis. This may be due to local affections of the liver, such as a gumma or cyst, or occur in association with passive hyperæmia due to heart disease, or adjacent to an inflamed gall-bladder. It may also form part of a tuberculous or malignant peritonitis.

Clinical Findings. There are usually no symptoms, but localised pain may occur.

Diffuse Perihepatitis (Sugar-iced Liver). This is associated with chronic proliferative peritonitis (see p. 119). A thick white fibrous coat forms over the liver, which can be stripped off. There is often thickening of the omentum, ascites, chronic pericarditis, arteriosclerosis and chronic nephritis (Pick's disease). There are usually no toxic symptoms and no jaundice.

Treatment. The ascites can be relieved by aspiration, and pot. iod. should be given by mouth in doses of 5 to 10 gr. (0.3 to 0.6 G.) t.i.d.

Clinical Findings. The clinical picture in amœbiasis and hydatid infection is considered separately (see pp. 738, 764). With pyæmic abscesses the patient is very ill, with a swinging temperature and rigors. The liver is usually enlarged and tender, and there may be icterus.

Prognosis. With multiple abscesses this is usually hopeless.

Treatment. No special treatment is available beyond treating the primary cause.

Suppurative Pylephlebitis

Definition. This term is synonymous with portal pyæmia. Suppuration occurs in the tributaries of the portal vein, in the vein itself and its branches.

Etiology. Suppurative pylephlebitis is most commonly due to an appendix abscess. Less often the condition is secondary to an amœbic liver abscess, to pus in the gall-bladder or bile ducts, to infection after rectal operations or pelvic operations in women.

Pathology. The liver is enlarged, perihepatitis is usually present, and abscesses may be seen on the surface or only on section of the organ. The portal vein or its branches contain disintegrating blood clot with a variable amount of pus.

Clinical Findings. The disease usually begins during convalescence from an operation for an appendix abscess. The patient becomes gravely ill with rigors, sweating and increase of temperature and pulse rate. This is followed in a few days by pain in the region of the liver.

On Examination : The patient looks ill, the tongue is dry and furred, and there may be slight icterus. The liver is found to be enlarged and tender. The spleen is not usually enlarged. The blood : There is usually a leucocytosis, but the systemic blood culture is often sterile. The temperature is irregular ; it may be remittent or intermittent.

Differential Diagnosis. The increase in the gravity of the patient's condition with the rigors and hectic temperature suggest pyæmia, and the evidence of liver involvement renders the diagnosis of portal pyæmia clear. In many cases, however, it is difficult, if not impossible, to diagnose during life. There may be no definite localising signs pointing to the primary source of the infection.

Course and Complications. The course is progressive. Complications, such as empyema or a lung abscess, may occur.

Prognosis. Death usually occurs in one to six weeks.

Treatment. It is doubtful whether there is any curative treatment available in established cases. Treatment is therefore palliative for relief of pain and discomfort, but, if indicated, antibiotics should be given.

Thrombosis of the Hepatic Veins

Primary thrombosis of the hepatic veins is known as *Chiari's disease*. The symptoms include sharp right upper abdominal pain radiating to the back, and, in some cases, shock, nausea, vomiting, and collapse. The liver is enlarged and tender, the spleen is enlarged, and there is ascites. There is no venous engorgement in the neck, as is met with in

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Treatment. The ascites can be relieved by aspiration, and pot. iod. should be given by mouth in doses of 5 to 10 gr. (0.3 to 0.6 G.) t.i.d.

Liver Abscess

Definition. Suppuration in the liver.

Etiology. The abscess may be due to the following causes:

1. Amœbiasis (see p. 738). It is then usually single.
2. Portal pyæmia. The infection may arise in the appendix ("appendicular liver"), or in other sites such as the prostate or rectum. It may be secondary to suppurative pyelophlebitis (see below). The abscesses are usually multiple.
3. Arterial pyæmia. This is often secondary to otitis media, the infection being carried to the liver by the hepatic artery.
4. Suppurative cholangitis. The infection spreads up the bile ducts.
5. Trauma. An abscess may form secondary to a wound of the liver.
6. Retrograde infection by the hepatic veins. This rarely occurs.
7. Direct spread of infection. This may be due to a subphrenic abscess or empyema of the gall-bladder.
8. Suppuration in a hydatid cyst.
9. Actinomycosis.

Clinical Findings. The clinical picture in amœbiasis and hydatid infection is considered separately (see pp. 738, 704). With pyæmic abscesses the patient is very ill, with a swinging temperature and rigors. The liver is usually enlarged and tender, and there may be icterus.

Prognosis. With multiple abscesses this is usually hopeless.

Treatment. No special treatment is available beyond treating the primary cause.

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Pathology. The liver is enlarged, perihepatitis is usually present, and abscesses may be seen on the surface or only on section of the organ. The portal vein or its branches contain disintegrating blood clot with a variable amount of pus.

Clinical Findings. The disease usually begins during convalescence from an operation for an appendix abscess. The patient becomes gravely ill with rigors, sweating and increase of temperature and pulse rate. This is followed in a few days by pain in the region of the liver.

On Examination : The patient looks ill, the tongue is dry and furred, and there may be slight icterus. The liver is found to be enlarged and tender. The spleen is not usually enlarged. The blood : There is usually a leucocytosis, but the systemic blood culture is often sterile. The temperature is irregular ; it may be remittent or intermittent.

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Course and Complications. The course is progressive. Complications, such as empyema or a lung abscess, may occur.

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Treatment. It is doubtful whether there is any curative treatment available in established cases. Treatment is therefore palliative for relief of pain and discomfort, but, if indicated, antibiotics should be given.

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right-sided cardiac failure. Death may occur from hæmatemesis. Secondary hepatic vein thrombosis may be associated with liver disease, with septicæmia, erythræmia vera, or with thrombo-phlebitis migrans.

Portal Thrombosis

(*Pylethrombosis. Pylephlebitis Adhæsiva*)

Definition. Thrombosis of the portal vein.

Etiology. Portal thrombosis is most often associated with cirrhosis of the liver, or with new growths in the pancreas, stomach or liver. In other cases it is due to syphilis of the portal vein, trauma, or to infections in the portal area, such as the intestines, appendix, spleen, pancreas or gall-bladder. It may occur in erythræmia vera and in splenic anæmia.

Pathology. The wall of the portal vein or its branches is generally thickened and the blood is clotted. The spleen is usually enlarged, but the liver may be normal in size. The mesenteric veins alone may be thrombosed, with secondary gangrene of the intestine, usually in the jejunum.

Clinical Findings. There may be hæmatemesis, acute abdominal pain or swelling of the abdomen due to ascites. In cirrhosis of the liver hepatic vein thrombosis may precipitate hepatic coma. With a mesenteric thrombosis (see p. 126) the symptoms resemble those of an acute abdominal emergency.

On Examination: The spleen may be enlarged and dilated veins seen around the umbilicus.

Differential Diagnosis. It is very difficult to make a certain diagnosis in cases of portal thrombosis, especially as it is so often associated with other severe diseases. The sudden onset of abdominal pain, hæmatemesis or ascites is very suggestive.

Course and Complications. The thrombosis may persist for many years or rapidly prove fatal. Recurrent attacks of hæmatemesis may occur.

Prognosis. This is very grave, but in some cases the patient survives the attack for several years.

Treatment. If the patient survives the immediate shock anti-coagulant treatment should be given (see p. 191) and a course of penicillin injections.

Cysts of the Liver

The following varieties of cyst may occur: 1. Blood and degeneration. 2. Dermoid. 3. Lymphatic. 4. Endothelial. 5. Due to bile duct obstruction. 6. Cystadenoma. 7. Hydatid. 8. Polycystic. This forms part of congenital polycystic disease of the kidneys (see p. 508). The solitary non-parasitic cyst is probably a cystadenoma arising from a congenital aberrant bile duct.

Clinical Findings. Unless the cyst is large it cannot be felt. In polycystic disease, however, the enlarged and irregular surface of the liver can often be detected. Cysts may rupture into the peritoneum,

causing severe shock, or a fatal hæmorrhage may take place into the cyst. A cyst may press on the bile ducts or duodenum, suppuration may occur, or the pedicle become twisted.

Hydatid Cysts

Etiology. The disease is due to infection with the *Echinococcus granulosus* (*T. echinococcus*) (see p. 764).

Pathology. The cysts may be multiple or single, deeply embedded in the liver substance or projecting from the surface. The liver is the organ most commonly affected in hydatid disease. The structure and contents of the cyst and the changes they may undergo are described on pp. 764, 765.

Clinical Findings. If the cyst is small or deep-seated, it may cause no symptoms. In other cases the patient complains of aching or of pain in the region of the liver, and he may give a history of residence in an infected area.

On Examination: The liver may be enlarged and a rounded swelling felt, depending upon the position of the cyst. The cyst may be revealed by X-ray examination. A hydatid thrill (see p. 764) is rarely palpable. The blood may show an eosinophilia. The Casoni intradermal test consists in the intradermal injection of 0.2 ml. of filtered hydatid fluid, obtained from a cyst of a sheep. A positive reaction is shown by the formation of an urticarial wheal in about 10 minutes, followed in a few hours by erythema and cedema around the site of the injection. There may also be a febrile reaction.

Differential Diagnosis. A hydatid cyst, if palpable, must be distinguished from a gumma or carcinoma of the liver, or an enlarged gall-bladder. It may also simulate a pleural effusion, if situated posteriorly. The diagnosis is usually suggested by the history of the case, the negative Wassermann and the positive blood and intradermal tests.

Course and Complications. The cyst may cure itself by inspissation. On the other hand, it may continue to grow, it may suppurate, or a hæmorrhage may occur into it. Rupture may take place into the abdomen, stomach, intestine, etc.

Prognosis. The mortality rate is about 15%.

Treatment. The cyst should not be tapped. If causing symptoms, it should be removed as completely as possible by an open operation. Aspiration is dangerous, as severe shock or death may occur if any of the fluid enters the peritoneum.

Calcification of the Liver

X-ray examination of the upper abdomen may reveal extensive areas of calcification in the liver. This is most often due to hydatid infection, but it may result from amœbiasis, syphilis, carcinoma, infective or vascular lesions.

Cirrhosis of the Liver

Definition. Hardening of the liver, due to the formation of fibrous tissue. The varieties of cirrhosis may be classified as follows: 1. Portal.

2. Post-necrotic. 3. Biliary. 4. Pigmentary. 5. Parasitic. 6. Syphilitic.
7. Congestive. 8. Active juvenile.

Portal Cirrhosis

(*Diffuse Hepatic Fibrosis. Alcoholic Cirrhosis. Laënnec's Atrophic Cirrhosis. Hob-nail Liver. Gin-drinker's Liver*)

Etiology. Clinical experience shows that most cases of cirrhosis of the liver are associated with persistent excessive intake of alcohol. The question whether alcohol exerts a direct toxic effect on the liver is not finally decided, although there is no doubt that after an attack of infectious hepatitis it acts as a liver poison. Cirrhosis may follow an attack of infectious hepatitis. It may at times develop in man either directly from protein nutritional deficiency, or indirectly because excessive consumption of alcohol results in a lowered protein intake, or causes a gastro-enteritis which interferes with the digestion and absorption of protein. Not all heavy drinkers develop cirrhosis. Lack of protein in the diet alone, does not always cause cirrhosis. Cirrhosis may also occur in Wilson's disease, or in association with ulcerative colitis cholestasis (intrahepatic biliary retention), hæmochromatosis, fibrocystic disease, right-sided heart failure and galactosæmia. The latter is an inborn error of carbohydrate metabolism due to lack of a galactose specific enzyme. *Predisposing causes:* 1. Age: Usually over 40, but cirrhosis may occur in children. 2. Sex: Males predominate. 3. Occupation: Especially those working in the liquor trade, and commercial travellers. 4. Climate and locality: It is more common in temperate zones.

Pathology. In the early stages the liver is enlarged and fatty, later it shrinks (Laënnec's atrophic cirrhosis). The surface is irregular, the projections being called "hob-nails." These are formed by hyperplasia of liver cells, and are yellowish on section (*Κίττός* = yellow). The liver is tough on section owing to the bands of fibrous tissue which surround several lobules. In many cases the liver is enlarged, with a finely granular surface, and the strands of fibrous tissue are perilobular in distribution. In other instances while portions of the liver are healthy, in some areas the liver lobules are replaced by newly regenerated liver cells. The spleen may be enlarged. A compensatory venous circulation is established on account of the portal obstruction. The main channels opened up are: Veins running from the bare area of the liver to the phrenic and intercostal veins. An anastomosis between the œsophageal veins and the coronary veins of the stomach. Dilated veins are often present in the lower part of the œsophagus, and in the stomach there may be erosions of the mucous membrane or dilated veins. Enlargement of the para-umbilical vein of Sappey, running in the falciform ligament and connecting the epigastric and portal veins. Dilatation of the veins around the umbilicus gives rise to the appearance known as the *caput Medusæ*. An anastomosis between the inferior mesenteric and the hæmorrhoidal veins. Hæmorrhoids are not common. Enlargement of the retroperitoneal veins of Retzius, establishing communication between the portal tributaries and those of the inferior vena cava (see Fig. 8).

FIG. 8. COMMUNICATIONS BETWEEN THE PORTAL AND SYSTEMIC VENOUS SYSTEMS

A. Between the retro-peritoneal veins which open into the lumbar and azygos veins and the veins of the intestine, especially in those regions where the gut is bound down to the abdominal parietes, *e.g.*, the duodenum and ascending and descending colon. This anastomosis was described by Retzius.

B. Veins in the liver substance and capsule may communicate with the phrenic and intercostal veins, where the liver and diaphragm are uncovered by peritoneum.

C. Very rarely the ductus venosus of the fœtus remains patent and connects the left branch of the portal vein with the inferior vena cava.

D.1. The falciform ligament contains veins which establish communication between the left branch of the portal vein and the veins of the abdominal wall. These vessels are known as the *para-umbilical veins of Sappey* and lie in close relation to the obliterated umbilical vein of the fœtus (*ligamentum teres*). In portal obstruction a large vein is often found in the free margin of the falciform ligament. Rokitsansky and Bamberger originally stated that this vessel was the patent umbilical vein. Sappey, however, asserted that the vein was always a para-umbilical vessel.

D.2. Veins running anteriorly in the falciform ligament connecting the umbilical or para-umbilical veins with a superior epigastric vein have been seen post-mortem in cases of portal obstruction.

E. The œsophageal branches of the left gastric vein anastomose with the systemic œsophageal veins which flow into the azygos system.

F. The gastric vein communicates with the phrenic vein.

G. Veins in the capsule of the kidney and the perirenal fat communicate on the left side with the veins of the descending colon, and on the right with veins of the ascending colon and duodenum. Congestion of the renal vessels has been described in cirrhosis and this may account for hæmaturia.

H. The veins of the descending colon may communicate with the spermatic plexus. Varicocele may occur in cirrhosis.

I. The superior hæmorrhoidal vein, a tributary of the inferior mesenteric vein, anastomoses with the middle and inferior hæmorrhoidal veins of the systemic circulation.

J. A communication between the left renal vein and the splenic vein has been described.

K. A communication between the splenic and azygos veins has been observed.

Peritoneal adhesions to the liver, stomach, duodenum and spleen favour the formation of anastomoses between portal and systemic veins.

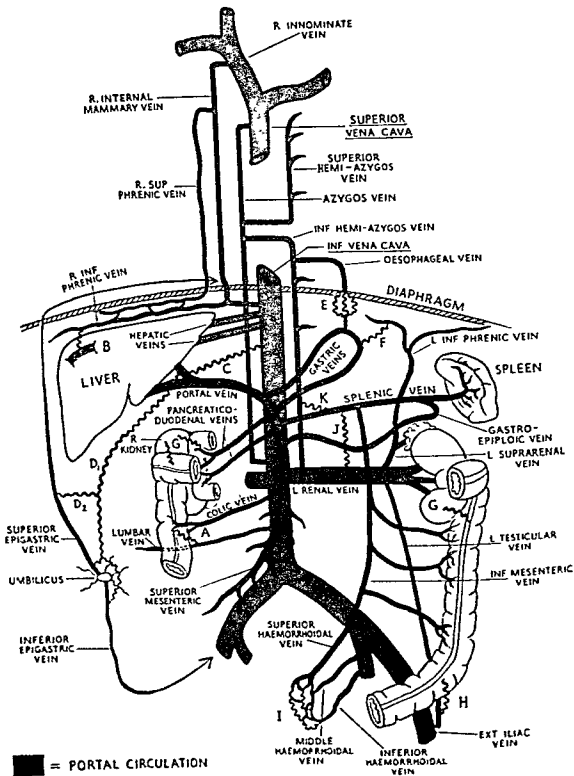


FIG. 8.

rise in the serum bilirubin, an increase in the urobilinogen in the urine, and the bromsulphthalein test is positive, there being an increased retention of the dye.

A barium swallow or œsophagoscopy will reveal the presence of œsophageal varices. The temperature is often irregular and slightly raised.

Differential Diagnosis. The symptoms in the early stages are those of chronic gastritis, or of tenderness over the liver, and there may be no indication that the liver is cirrhotic until pressure manifestations occur, such as hæmatemesis, or until the liver is definitely enlarged. Other causes of hæmatemesis, such as gastric ulcer, must then be excluded. The barium meal will afford evidence of gastric ulceration.

Enlargement of the liver necessitates a consideration of other causes than cirrhosis, such as malignant disease, syphilis, splenic anæmia, passive hyperæmia, amyloid degeneration, a hydatid cyst, an abscess, leukæmia or Hodgkin's disease. In malignant disease the liver is usually more irregular, definite nodules with central umbilication are palpable in some cases, and jaundice tends to be more intense. In some cases, however, the liver is infiltrated with secondary deposits, and no jaundice is seen. The growth is usually secondary to a lesion elsewhere. In syphilis the Wassermann reaction is positive, and there is amelioration of the condition with the administration of iodides. In splenic anæmia the spleen is usually considerably enlarged before the liver enlarges. In passive hyperæmia there is evidence of heart failure, and expansile pulsation may be detected in the liver. In amyloid degeneration the patient is usually suffering from a definite wasting or suppurative disease. The blood examination is of value in the diagnosis of hydatid disease, abscess and leukæmia. In Hodgkin's disease, enlarged lymph nodes are usually found elsewhere. The alcoholic history and appearance of the patient are also of value.

In the ascitic stages other causes of ascites must be considered (see p. 121). Cholæmia or hepatic toxæmia resembles uræmia in some respects clinically, and the non-protein nitrogen content of the blood may be raised.

Course and Complications. In the early stages the disease may pursue a very slow course, and arrest may even occur. Complications include: Hæmatemesis, portal thrombosis, hepato-renal failure, pulmonary tuberculosis, tuberculous peritonitis, hæmorrhagic pleural effusion, pneumonia, and peripheral neuritis.

Prognosis. This is very grave, except in the early stages, and the patient usually dies a few years after the diagnosis is made. Hepatic coma and hæmatemesis are serious complications.

Treatment. In the early stages the patient must give up all alcohol and spiced foods, and no tinctures or spirits must be given as medicines. The diet should be rich in meat, fish, eggs, milk, fruit, green vegetables and carbohydrate-containing foods. It should contain about 800 G. carbohydrate, 50 to 150 G. protein, and 100 G. fat. Brewers' yeast, $\frac{1}{2}$ oz. (15 G.) may be given in milk twice daily, or two Bplex capsules a day, and aneurin. hydrochlor. 5 mg. taken by mouth daily. An intra-

Clinical Findings. The patient is often an adult male, over the age of 40, who gives a history of over-indulgence in alcohol for several years. In the early stages the symptoms are due to chronic gastritis. The patient complains of flatulence, nausea, retching or vomiting small quantities of fluid on rising, and of a lack of desire for breakfast. He may have headache, recurrent attacks of epistaxis and constipation. The first symptom in some cases is a hæmatemesis of half a pint (300 ml.) or more. In the later stages, the patient complains of increasing weakness, dyspnœa, and perhaps of swelling of the abdomen and legs. In other cases there is a history of one or more attacks of jaundice, probably due to infectious hepatitis.

On Examination : The facies is usually suggestive, the patient being well nourished with dilated venules on the cheeks, and the eyes are congested and watery. The tongue is furred and the breath is often offensive. The liver may be felt enlarged, a little irregular and firm, and the spleen may be just palpable.

Later, the patient presents the typical hepatic facies ; the face is thin and the nose prominent ; the complexion is rather sallow, and dilated venules are seen on the cheeks and nose. The chest, arms and legs are wasted, but there may be swelling of the legs due to œdema. The œdema may be due to various causes, such as partial obstruction of the inferior vena cava or abdominal lymphatics, to loss of blood protein into the ascitic fluid, or to a toxic effect on the capillaries. The abdomen is distended. Free fluid may be detected in the abdomen and the liver may be felt on "dipping" below the costal margin to be firm and irregular. In other cases the liver is not palpable until the fluid has been removed from the abdomen, or the liver may have shrunk and not be palpable. "Vascular spiders" may be seen on the face, arms, hands and upper part of the trunk. They are red and are composed of a central arteriole which pulsates, with radiating legs. Pressure on the central arteriole with a pin causes the legs and the whole red area to blanch. The palms of the hands, especially the thenar and hypothenar eminences and the tips of the fingers, are sometimes hot and red, the so-called "liver palms" and the nails may be white, the nail bed being opaque. Dupuytren's contracture of the palmar fascia may be associated with cirrhosis. The patient may complain of burning feet. Endocrine disturbance may be shown by testicular atrophy and gynæcomastia in males, and by hirsuties or disturbance of the periods in females. The dilated veins may be seen in the abdominal wall, as described above (see Fig. 8). A venous hum may be heard over the lower part of the sternum and the liver. Symptoms of toxæmia may be present ; the patient complains of headache, inability to concentrate, and drowsiness. The skin is usually sallow or slightly icteric, and muscular tremors or twitching may be seen. This may pass on to hepatic coma (see p. 101). The urine is concentrated and may contain bile. The blood shows an excess of bile pigment, and in the later stages of the disease a macrocytic anæmia may develop. Further, the plasma proteins are low, or if the total protein content is normal, the globulin figure is higher than the albumin. Liver function tests show a moderate

not be administered, and if drugs are required to calm the patient, paraldehyde may be given, as for hepatic coma (see p. 101).

Post-necrotic Cirrhosis

Etiology. Post-necrotic cirrhosis, or scarring of the liver, follows widespread necrosis of liver cells, as may occur after infectious hepatitis, or in acute massive liver necrosis due to poisoning from phosphorus, carbon tetrachloride or cincophen, when the patient does not die during the acute phase. The reason why it occurs in some cases of hepatitis and not in others is unknown.

Pathology. The liver is small, with nodules and depressions on its surface. The nodules are caused by proliferating liver cells and the depressions are due to areas of connective tissue with collapse of the liver reticular structure. Broad bands of connective tissue are formed.

Clinical Findings. This disease is not uncommon in young people, following one or more attacks of infectious hepatitis. The patient feels ill, is jaundiced, has abdominal pain, and may suffer from hæmatemesis or ascites. The serum globulin is raised, and the alkaline phosphatase in the serum is also usually above normal.

Course. In some cases there is rapid deterioration, the condition resembling acute massive necrosis of the liver.

Differential Diagnosis. The condition resembles that met with in portal cirrhosis, but there is usually a history of infectious hepatitis. The jaundice is deeper than in portal cirrhosis.

Treatment. This is similar to that for portal cirrhosis.

Biliary Cirrhosis

(Unilobular Cirrhosis)

There are two types of primary or chronic obstructive jaundice (cholestasis) which will be described separately, cholangiolitic biliary cirrhosis and obstructive biliary cirrhosis.

Primary Biliary Cirrhosis (Cholangiolitic Biliary Cirrhosis. Hanot's Cirrhosis)

Definition. A disease characterised by enlargement of the liver, persistent jaundice, and periodical febrile attacks.

Etiology. The cause is not known. Alcohol is probably not a causative factor. *Predisposing causes:* 1. Age: 35 to 70 years, but it may occur in children. 2. Sex: Nearly always women.

Pathology. Post-mortem the liver is enlarged, with a smooth surface and dark green colour. It is firm on section, and a fine perilobular fibrosis is present. The larger bile ducts are normal, the smaller ones show cholangitis or pericholangitis. The spleen is normal or enlarged. The portal lymph nodes may be enlarged.

Clinical Findings. The disease is very rare. The onset is gradual, the patient complaining of loss of appetite, attacks of nausea or diarrhoea, jaundice and itching of the skin. Pain may be felt in the region of the liver or of the spleen.

On Examination: The patient is jaundiced, but not usually very deeply. The liver is found to be enlarged, and may extend from the fourth rib to 4 inches (10 cm.) below the costal margin. It feels smooth and firm.

muscular injection of 2 ml. of Hepastab should be given twice a week. If there is severe polyneuritis or mental confusion 100 mg. of aneurin. hydrochlor. and 300 mg. of nicotinamide should be injected intramuscularly daily. The bowels should be kept acting daily with salines, such as mag. sulph. 60 gr. (4 G.) *mane*. If there is persistent jaundice and a high serum gamma-globulin prednisone may be given in doses of 5 mg. twice or three times daily. If the Wasserman reaction is positive, a course of pot. iod. 5 to 60 gr. (0.3 to 4 G.) t.i.d. should be given for 2 to 3 months. If there is hæmatemesis no morphine must be given, as owing to failure of hepatic detoxication, even $\frac{1}{2}$ gr. (10 mg.) may prove fatal.

Ascites. In acute ascites due to alcoholic cirrhosis, rest in bed with a mixed diet, as described above, and no alcohol, may cause a rapid disappearance of the fluid. In the more chronic types it may be possible to abolish the ascites by a high protein, low sodium diet, combined with mercurial diuretics and ammonium chloride. A preliminary paracentesis is not always necessary. The patient is given a diet containing 120 G. protein, with a sodium content up to 500 mg. a day. By the use of Casilan, 60 G. in a pint (600 ml.) of water during the day, it is possible to obtain enough protein without increasing the sodium intake. The caloric value of the diet should be about 2,500. The fluid intake should be restricted according to the fluid output. Two ml. of mersalyl are injected intramuscularly twice a week, and ammonium chloride is given by mouth, 1 G. t.i.d. The ammonium chloride can be given as 0.5 G. enteric coated tablets. It is also advisable to give potassium chloride, 1 G. daily. After several months it is usually possible to increase the sodium intake, without recurrence of ascites. A careful watch must be kept for early signs of hepatic coma, such as mental changes, when the administration of ammonium chloride must be discontinued.

The use of other diuretic agents is described on p. 243.

Various operations have been devised either to drain away the fluid or to relieve portal hypertension. The Talma-Morison operation is the most satisfactory of the former, adhesions being formed between the omentum and the anterior abdominal wall. In the latter type of operation the portal vein is anastomosed to the inferior vena cava, thus establishing a portacaval shunt. Encephalopathy, with mental confusion, flapping tremor, a raised arterial ammonia, urinary incontinence and disorientation may be relieved by the oral administration of lactulose (Duphalal) 30 G. b.i.d.

Rupture of œsophageal or gastric veins. This constitutes a medical emergency, demanding prompt treatment. A blood transfusion should be given using fresh blood. Gastric tamponade, by a Sengstaken inflatable œsophageal tube passed into the stomach is now seldom used. Vasopressin (Pitressin) 20 units in 1 ml. diluted in 5% dextrose injected intravenously over a period of 10 minutes has been found successful in controlling bleeding from œsophageal varices, but should not be given if there is disease of the coronary arteries. Feeding is by intragastric or intravenous drip, with 10 to 20% dextrose solution. Morphine must

a honeycomb appearance due to dilatation of the bile ducts. Fibrosis is present around the bile ducts, and this fibrosis may be unilobular or multilobular. Calculi may be present in the extrahepatic bile ducts. The spleen is not usually enlarged.

Clinical Findings. The onset is gradual, with progressive jaundice.

On Examination : The liver is not generally palpable, but an enlarged gall-bladder may be felt. The blood : The van den Bergh reaction is direct. The urine : Bile pigment is present. The faeces are pale owing to absence of bile.

Differential Diagnosis. The diagnosis involves consideration of the causes of obstructive jaundice, especially that due to gall-stones. The onset of cholæmic symptoms indicates that there is further failure of hepatic function.

Course and Complications. The course is progressive, unless the obstruction is removed before irreparable damage has been done to the liver.

Prognosis. Early treatment may effect a cure. The outlook is very grave with the onset of coma.

Treatment. The obstruction should be removed, if possible, by operation.

Other Varieties of Cirrhosis

These include pigmentary cirrhosis, parasitic cirrhosis, syphilitic cirrhosis, congestive cirrhosis and active juvenile cirrhosis.

Pigmentary cirrhosis. This is exemplified by hæmochromatosis (see p. 687).

Parasitic cirrhosis. This is due to infection of the liver with such parasites as the *Bilharzia mansoni* or the liver fluke (*Fasciola hepatica*).

Syphilitic cirrhosis. In congenital syphilis a pericellular cirrhosis may be noted. In acquired syphilis single or multiple gummata are found in the liver. Deep scarring in a healing gumma may produce the *hepar lobatum*.

Congestive cirrhosis. This is due to heart failure. Fibrosis occurs chiefly around the central hepatic veins.

Active juvenile cirrhosis. This is met with chiefly in young women. It may develop insidiously or have an onset resembling that of viral hepatitis. The jaundice persists. The spleen may be enlarged. Lupus erythematosus cells are found in the blood in about 10% of cases. The disease is slowly progressive, death occurring in a few years.

Jaundice (*Icterus*)

Definition. A condition characterised by excess of bile pigment in the blood, with a yellow discoloration of the skin and conjunctivæ.

Physiology and Pathology. Bile pigment is made from red cells engulfed by the phagocytic reticulo-endothelial cells in the bone marrow, spleen and liver. The reticulo-endothelial cells in the liver (Kupffer cells) are situated in the walls of the intrahepatic branches of the portal vein. The bilirubin, which is the globin-free, iron-free fraction of hæmoglobin, is carried to the liver in the blood stream, attached to albumin, in an unconjugated form. This is insoluble in water and does not pass into the urine. It gives an indirect van den Bergh reaction as

The spleen may be palpable. There is no ascites. The fingers are often clubbed, and hypertrophic osteo-arthritis may be seen in the wrists or other joints. The serum may contain antibodies giving a distinctive pattern of cytoplasmic staining in unfixed sections of thyroid gland, stomach and kidney as shown by immunofluorescence.

There is an increase of immunoglobulin (IgM) in the plasma cells found in the early lesions of primary biliary cirrhosis, and also an increase in the circulatory type of IgM. The normal figure is 60 to 80 mg./100 ml., and in primary biliary cirrhosis it may rise to over 500 mg./100 ml. This test may obviate a laparotomy to exclude other varieties of biliary obstruction or cholestasis. The blood: There is a hemolytic anemia, but the leucocytes are often increased up to 12,000 per c.mm. or more. The van den Bergh reaction is indirect. Similar findings are met with in chronic chlorpromazine poisoning. The urine: This contains urobilin and increased urobilinogen. The faeces: Stercobilin is diminished.

Differential Diagnosis. It may be confused with acholuric jaundice, Banti's disease, portal cirrhosis, infectious hepatitis and xanthomatous biliary cirrhosis. The characteristic features are the persistent jaundice of a rather mild degree, the absence of ascites, and the enlarged liver. The red cells show no increased fragility as they do in acholuric jaundice. In Banti's disease there is usually a leucopenia, and haemorrhages occur before the onset of jaundice. Portal cirrhosis is characterised by a milder degree of jaundice and the tendency to ascites. In obstructive jaundice the faeces contain little or no bile. In xanthomatous biliary cirrhosis the blood cholesterol is raised and xanthomatous nodules appear in the skin, especially on the backs of the elbows, with xanthomatous patches in the eyelids.

Course and Complications. The course is usually slowly progressive, but there is a tendency to periodical febrile attacks with intensification of the jaundice. Complications include intercurrent diseases, such as erysipelas or pneumonia. Coma occurs in the final stages, and occasionally there is ascites or gastric haemorrhage.

Prognosis. The disease is usually fatal in about 5 or 6 years from its onset.

Treatment. This is similar to that required for portal cirrhosis. For pruritus cholestyramine chocolate flavoured tablets, 6-10 G. daily may be given for 4 to 7 days. If this fails methyltestosterone 25 mg. tab. may be tried, 1 tab. t.d.s. for a few days. To prevent osteoporosis 100,000 units of vitamin A and D should be injected intramuscularly every 4 weeks and six 1.5 G. tabs. of calcium (Sandoz) taken daily.

Xanthomatosis should be treated with clofibrate androsterone capsules (Atromid), 6 to 9 daily in divided doses.

Obstructive Biliary Cirrhosis (*Charcot's Cirrhosis*)

Etiology. Charcot's cirrhosis results from obstruction and infection of the bile ducts, as by a calculus, adhesions around the common duct, or carcinoma of the head of the pancreas.

Pathology. At autopsy, the liver is usually contracted. The surface is irregular and the colour is dark green. On section it presents

in hæmolytic jaundice. Bilirubin is conjugated with glucuronic acid in the liver, and is then excreted as a water-soluble glucuronide. This gives a direct van den Bergh reaction. The bilirubin glucuronide is oxidised to biliverdin which is excreted *viâ* the bile canaliculi to the bile duct. It is reduced in the intestines by the action of micro-organisms into stercobilinogen, which is the same as hydrobilirinogen or urobilinogen. This is a colourless compound. The greater part is probably oxidised in the large intestine to stercobilin, which is the same as hydrobilirin or urobilin. This is a brown substance and colours the fæces. A small amount of stercobilinogen is absorbed into the blood, and carried by the portal vein to the liver. The greater part of the absorbed stercobilinogen is re-excreted in the bile, either as bilirubin or stercobilinogen, but a trace may pass from the liver by the hepatic veins and be excreted from the general circulation in the urine as urobilinogen, which is oxidised to urobilin when exposed to the air. When the liver is damaged the stercobilinogen, which is absorbed from the intestine by the portal vein to the liver, is not recovered by the liver and re-excreted in the bile, but passes to the general circulation and is excreted in the urine in pathological amounts as urobilinogen and urobilin. This implies that in addition to the liver damage, a certain amount of bile pigment is reaching the intestines, and so any obstruction, if present, is incomplete.

The Classification of Jaundice. None of the classifications propounded can be accepted with enthusiasm, and this is inevitable owing to the inadequacy of present knowledge. The old division of jaundice into obstructive and non-obstructive groups has the merit of being non-committal as regards the nature of the second group. McNee's classification into obstructive, toxic and infective hepatic (hepatocellular), and hæmolytic cases subdivides the non-obstructive group, but is liable to criticism. The nomenclature is mixed, being based both on pathogenesis and on etiology. Further, such sharp divisions probably never occur in practice. In extrahepatic obstruction of the bile ducts, unless only of short duration, there is probably always some intrahepatic damage, and in hæmolytic jaundice there is also usually a hepatic element. Arnold Rich has proposed a classification based on clinical laboratory findings and theoretical views as to pathogenesis. He recognises two main types of jaundice: 1. *Retention jaundice.* In these cases there is excessive production of bile pigments by the reticulo-endothelial cells, and diminished excretion of bile by the liver cells. The latter is due to subnormal function caused by various factors such as anoxæmia, febrile disease or immaturity of liver cells. The excess of bile pigment does not pass through the epithelial cells of the liver and enters the general circulation by the hepatic vein (see Fig. 9). 2. *Regurgitation (obstructive) jaundice.* The bilirubin in the blood is not excreted normally, either owing to necrosis of the liver cells or to obstruction in the bile canaliculi or ducts. The ducts then rupture (see Fig. 9) and bile passes back into the blood channels of the liver. *A combined form of jaundice* may also occur, in which there is an excessive production of bile pigments and a regurgitation of bile which has been excreted into the canaliculi.

Obstructive Jaundice

The obstruction may be extrahepatic or intrahepatic.

Extrahepatic Obstruction. *Causes in the bile duct:* These include a gall-stone, a round worm, plugs of mucus, a hydatid cyst or a projection of a carcinoma arising in the gall-bladder. *Causes in the wall of the duct:* A new growth, stricture or catarrhal inflammation. *External pressure on the duct:* Carcinoma of the head of the pancreas, chronic pancreatitis, enlarged lymph nodes due to Hodgkin's disease, malignant disease, and rarely tuberculosis or glandular fever, or a gumma in the portal fissure, carcinoma or ulcer of the stomach or duodenum, renal or adrenal tumours, an aneurysm of the celiac axis, hepatic or mesenteric arteries.

Surgical Jaundice

This is due to posthepatic obstruction, the common causes being a calculus in the common bile duct, adhesions or stenosis affecting the bile duct system, carcinoma of the pancreas, of the hepatopancreatic ampulla (ampulla of Vater) or of the bile duct, or enlarged lymph nodes in the portal fissure pressing on the bile duct. The jaundice is persistent and pruritus is often a prominent feature. The signs of obstruction are present: Absence of bile from the faeces, presence of bilirubin, and absence of urobilinogen in the urine. The direct van den Bergh reaction is positive. The alkaline phosphatase reading is usually over 30 King-Armstrong units, and the flocculation liver function tests are negative. If after about 4 to 6 weeks the diagnosis is in doubt it is usually wise to advise a laparotomy.

Intrahepatic Obstruction. This may be due to cholangitis, cirrhosis or carcinoma of the liver, or to hepatitis or necrosis of the polygonal cells of the liver. An obstructive type of jaundice has been met with in patients taking chlorpromazine.

The varieties of obstructive jaundice, such as that due to carcinoma of the liver or pancreas, or to gall-stones, etc., are considered under their respective headings.

Clinical Findings. The urine is dark brown owing to the presence of bilirubin, but contains no urobilin. The faeces are clay-coloured, and free from stercobilin. They may contain a trace of stercobilinogen. The blood contains an excess of bilirubin and gives an immediate direct van den Bergh reaction. Often the obstruction is only partial. The motions are then pale but contain some stercobilinogen, the urine contains bilirubin and a trace of urobilin, and the blood still gives an immediate direct van den Bergh reaction, but the total amount of bilirubin in the blood is less than in complete obstruction.

Hepatocellular Jaundice

This may be caused by drugs and poisons (see p. 96). It also results from infections as in typhoid fever, Weil's disease, relapsing fever, pneumonia, infectious hepatitis, yellow fever, and septicæmia. It is met with in pregnancy, right-sided heart failure and cirrhosis of the liver.

Jaundice in New-born Infants (*Icterus Neonatorum*)

The following varieties are described :—

Mild Types. Physiological, appearing during the second or third day of life and lasting for 1 or 2 weeks. The hyperbilirubinæmia is of the indirect variety and probably due to an increased formation of bile pigment, dependent less upon polycythæmia than on a diminished excretory power of bile pigment by the liver cells.

Severe Types. These may be due to congenital stenosis or absence of the bile duct, gall-stones, or congenital syphilis of the liver. Infections of the umbilicus or in the intestines may cause severe *icterus neonatorum*. **Neonatal hepatitis.** The liver is enlarged and the motions are pale. Large multinucleated cells are found in the liver. The cause is unknown and the outlook is unfavourable. Other causes include *congenital toxoplasmosis*, *hypothyroidism*, and the *insipissated bile syndrome* from various causes. *Erythroblastosis foetalis* is an important cause of severe jaundice in the new-born, and will now be considered.

Hæmolytic Disease of the New-born (*Erythroblastosis Foetalis*)

This is a disease which may affect the foetus or new-born infant. There may be generalised œdema of the foetus, called *hydrops foetalis*, or a macerated still-born foetus with cirrhosis of the liver. In other cases there is *icterus gravis neonatorum with erythroblastosis*, or there may be severe anæmia with slight jaundice, a condition called *anæmia hæmolytica neonatorum*. Owing to destruction of red cells in the blood, red cells are formed in excess in other sites than the bone marrow, spleen and liver, such as the kidneys and adrenals. This is called extra-medullary erythropoiesis or erythroblastosis. In the blood we find an excess of nucleated red corpuscles. Erythroblastosis foetalis is usually associated with the Rh factor. The Rh factor is an agglutinin, that is, a substance in red cells which reacts with its corresponding agglutinin, present in the plasma of an incompatible blood, so that if a transfusion of such blood is given to a person whose red cells contain this agglutino-gen, agglutination of his red cells occurs, with subsequent hæmolysis. This agglutinin is present in 85% of people, and they are called Rh-positive. The factor is called Rh because it is present in the blood of the Rhesus monkey. If the father is Rh-positive and the mother is Rh-negative, the child may be Rh-positive, but not every child does inherit the Rh factor from the father. If it does, the red cells of the foetus contain the Rh agglutinin. This may provoke the formation in the mother's plasma of an anti-Rh agglutinin, a process known as iso-immunisation. It is necessary to postulate that some of the red cells of the foetus pass into the maternal circulation. If these agglutinins now pass across the placenta into the foetal circulation, agglutination and destruction of the red cells of the foetus will occur. The first child of such a marriage is not often affected, possibly because iso-immunisation of the mother takes place slowly, and it is only during the second or third

Clinical Findings. These vary in accordance with the degree of intrahepatic obstruction of the bile canaliculi. If there is no obstruction the urine contains no bilirubin or only a trace, and there is usually a small amount of urobilin. The faeces are normal in colour and the blood contains a slight excess of unconjugated and conjugated bilirubin, the blood may give a delayed direct van den Bergh reaction. If there is, in addition to the liver damage, some intrahepatic obstruction, the urine contains a varying amount of bilirubin with urobilin, the faeces are pale, and the blood contains an excess of bilirubin. The van den Bergh reaction may be immediate direct or biphasic. The serum transaminase readings are raised.

Hæmolytic Jaundice

Etiology. This may occur in acholuric jaundice, in splenic anæmia, in pernicious anæmia, and in paroxysmal hæmoglobinuria. It may also result from blood transfusion when the blood is incompatible, or in association with *Diphyllbothrium latum* infestation. Other causes include poisoning from sulphonamide drugs, malaria, blackwater fever, hæmorrhagic septicæmia, polycythæmia rubra, sickle-cell anæmia, and Lederer's anæmia.

Pathology. The spleen is often enlarged, and there is anæmia. In these cases the renal threshold for bilirubin is often raised, so that the blood bilirubin is over 8 mg./100 ml., without bilirubin appearing in the urine. The jaundice is usually slight.

Clinical Findings. The jaundice is not usually severe. The urine may contain a trace of bilirubin, but there is frequently a marked excretion of urobilin. The faeces are dark brown and contain an excess of stercobilin. The van den Bergh reaction is a delayed direct one. The serum unconjugated bilirubin is increased, and the conjugated bilirubin is very slightly increased. In long-standing or severe cases, where there is more damage to the liver cells, bilirubin appears in greater quantity in the urine and an immediate direct van den Bergh reaction is given by the blood.

Constitutional Hyperbilirubinæmia

This is a rare condition in which the patient is permanently slightly jaundiced, and which may be present from birth. It has been called by other names, such as familial non-hæmolytic jaundice. There is no evidence of a hæmolytic anæmia, the liver function tests are normal, and the indirect van den Bergh reaction is positive. The condition is of no serious significance, and it is thought that it may be due to a raised hepatic threshold for the passage of bilirubin from the blood into the bile capillaries.

Another similar group of cases may be due to an inborn or acquired error of metabolism, in which the liver cannot adequately excrete bilirubin, and also bromsulphthalein, and the dye used in cholecystography. In addition to the impaired bromsulphthalein excretion, and the failure to visualise the gall-bladder in the cholecystogram, the direct van den Bergh reaction is positive.

3. *Intrahepatic cholestasis*. The drugs may be (a) sensitising type, such as chlorpromazine (Largactil) or promazine (Sparine), or (b) Non-sensitising, such as methyltestosterone. Norethandrolone (Nilevar). Norethynodrel (Enavid).

The Recurrent Jaundice of Pregnancy

This usually occurs during the last 3 months of pregnancy. It is characterised by pruritus, jaundice, pale stools and bilinuria. The alkaline phosphatase in the serum is raised, the flocculation tests are normal. Plugs of bile form in the intrahepatic bile ducts causing cholestasis. The condition disappears after childbirth and tends to recur in a subsequent pregnancy.

Infectious Hepatitis

Definition. Infectious hepatitis is a condition, due to an infective agent, in which there are inflammatory changes in the liver, and which is often accompanied by jaundice. It is now usually believed that what was formerly described as catarrhal jaundice, was in reality infectious hepatitis. Epidemics of jaundice have been recorded for over 200 years, especially in times of war.

Etiology. The icterogenic agent is a virus, virus A, not transmissible to animals, and spread either by naso-oral droplets or by contamination of water or oysters by infected faeces. There may be more than one causative virus. It may possibly be spread by flies. Carriers usually are incubating the disease. Alcohol appears to be a predisposing factor.

Pathology. The disease is probably a systemic infection with a predilection for the liver. Aspiration biopsy of the liver shows necrosis and autolysis of the cells of the hepatic lobules, with cellular infiltration around the periphery of the lobules. There may be proliferation of the bile ducts in the portal tracts. In some cases, a permanent cirrhosis develops, in others there is a mild residual fibrosis which may ultimately resolve.

Clinical Findings. The mode of onset, course and severity of the illness are variable. Outbreaks of jaundice were reported in Wensleydale by Pickles in 1930, by Newman in Sussex in 1942, by Cookson in Gloucestershire in 1944, and during the 1939-45 war epidemics of infectious hepatitis occurred especially amongst the troops in Syria, N. Africa, and Italy. Four modes of onset have been recognised, 1. Insidious, with anorexia, vomiting and gastro-intestinal symptoms. low grade fever and jaundice appearing after 3 or 4 days. 2. Febrile, the temperature suddenly rising to 101° to 103° F. (38·3° to 39·4° C.). Jaundice occurs 2 to 4 days later. 3. Ambulatory, the patient continuing with his work until he is noticed to be jaundiced. 4. Hepatic, without any manifest jaundice. Occasionally there is urticaria, morbilliform-rashes or arthralgia. The temperature usually falls to normal in 3 to 4 days, and the liver gradually enlarges and becomes tender, the spleen is seldom palpable. After a pre-icteric stage of 4 to 5 days, the temperature may rise again, as the jaundice appears. The stools may or may not be clay-coloured and there may be constipation or diarrhoea. Recovery is

pregnancy that sufficient agglutinin is formed to cause hæmolytic. If the mother is transfused with Rh-positive blood of the correct group, she is liable to have a transfusion reaction at the first transfusion, as she already has anti-Rh agglutinin in her blood. Erythroblastosis foetalis is not always due to the Rh factor. In about 4% of cases it occurs when the parents are of different groups, the agglutinin in the mother's blood which damages the foetal cells being either anti-A or anti-B. Usually such an agglutinin is absorbed, but in a few cases it remains free to attack the red cells. In other cases pathological jaundice of the newborn may be due to toxoplasmosis.

An additional feature leading to hæmorrhages in some of these cases is hypoprothrombinæmia. The jaundice is present at birth or appears within 24 hours and the liver and spleen are enlarged. Some infants recover spontaneously, and some who survive, subsequently develop nervous lesions due to jaundice of the striato-pallidal portion of the brain (kernicterus). The manifestations of this include choreo-athetosis, extrapyramidal spasticity, opisthotonos and mental deficiency.

Treatment. This consists in the intravenous or intramedullary transfusion of 60 to 80 ml. of Rh-negative Group O blood. The transfusion should be repeated daily for 2 to 8 days. If such blood is not available and the condition of the infant is critical, the mother's red cells, washed and suspended in saline, may be used for the transfusion. The mother's milk may contain the agglutinin in high concentration, and for this reason some authorities advise that the infant shall not be breast fed. Exchange transfusion of Rh-negative blood may be carried out during the first 6 to 9 hours. This gives the infant an adequate supply of Rh-negative cells, does not increase the blood volume and is likely to prevent kernicterus developing. A polythene catheter is inserted into the umbilical vein and by means of a 20 ml. syringe with a three-way stopcock, the infant's blood is withdrawn from the vein and the Rh-negative blood is injected, alternately. The donor's blood is concentrated before injection by withdrawal of plasma to a red cell content of about 6 millions per ml., and a total amount of about 400 ml. are injected. Great care must be taken to prevent air getting into the system. For hypoprothrombinæmia vitamin K should be administered, 1 ml. (containing 5 mg.) of inject. menaphthoni (B.P.) being injected intramuscularly daily. If the condition is still deteriorating immediate splenectomy affords a hope of cure.

Jaundice due to Drugs and Poisons

The following groups may be recognised:—

1. *Hepatocellular damage.* Drugs and poisons include carbon tetrachloride. Tetrachlorethane. Chloroform. Trilene. D.D.T. Trinitrotoluene. Muscarine. Yellow phosphorus. Manganese. Gold. Mercury. Arsenic. Ferrous sulphate. Urethane. 6-mercaptopurine. Tetracyclines. Phenindione (Dindevan).

2. *Hepatitis-like lesions.* Drugs such as Iproniazid (Marsilid). Isoniazid. Phenelzine (Nardil) etc.

due to the same virus that is believed to cause infectious hepatitis. The difference in the incubation periods is opposed to this view, although this might be explained by the belief that the viruses are introduced at different sites in the two diseases.

Pathology. The microscopical findings in the liver, in specimens obtained by liver puncture in cases of serum jaundice, are similar to those seen in infectious hepatitis.

Clinical Findings. The incubation period is about 50 to 160 days. Homologous serum jaundice may arise in a variety of ways, of which the following are the most important:—As the result of the prophylactic inoculation with measles convalescent serum or plasma, or mumps convalescent plasma. It may also result from the use of syringes contaminated with infected blood, and employed either for intravenous, intramuscular or subcutaneous injections, or for removing blood by venepuncture, when a small quantity of the material in the syringe is sucked back into the vein as the needle is removed. This latter group includes post-arsenical jaundice occurring in venereal disease clinics, jaundice following the injection of penicillin or thiopentone sodium (Pentothal), and occasional outbreaks of jaundice in clinics for the treatment of diabetes mellitus, or arthritis, or in sanatoria. Clinically, the illness closely resembles that described above as characteristic of infectious hepatitis, but some authorities have pointed out differences in the clinical features, especially the occurrence of erythema multiforme, stiff joints, splenomegaly and the usually apyrexial course in serum jaundice.

Treatment. *Prophylactic.* Human serum is no longer used in the preparation of yellow fever vaccine and this type of homologous serum jaundice has now ceased. Jaundice due to the use of contaminated syringes can be eliminated by using disposable syringes. All-glass syringes should be sterilised by dry heat at 160° F. (71° C.) for an hour, if feasible. In any case, syringes should be well washed out after use, and boiled between each patient, even when the syringe is only used for withdrawing blood.

Curative. This is the same as for infectious hepatitis.

Lupoid Hepatitis

This may follow an attack of infectious hepatitis; the jaundice continues, the liver and spleen are enlarged and palpable, and L.E. cells (see p. 655) are found in the blood. The patient is often a woman, under the age of 40. From time to time there may be fever, arthritis, or colitis. The response to prednisone is usually good initially, but the ultimate outlook is very unfavourable.

Acute Massive Liver Necrosis

(Acute Yellow Atrophy of the Liver)

Definition. A disease characterised by progressive jaundice, fever, severe nervous disturbances and shrinking of the liver.

Etiology. The cause is not known. The acute necrosis may occur

usually complete in 6 to 8 weeks. *Laboratory Findings*: The white cell count is normal or there is slight leucopenia. The sedimentation rate of the red cells is usually normal in the icteric stage, and raised in the pre-icteric stage and during convalescence. The van den Bergh test gives usually a positive direct reaction, falling to normal in 40 days or less. The urine occasionally contains urobilinogen in the pre-icteric stage, later bilirubin is present. Liver function tests, such as the bromsulphthalein and flocculation tests and the galactose tolerance test, usually give positive results. The alkaline phosphatase reading is raised to about 25 King-Armstrong units. The serum-transaminase readings tend to be higher than in jaundice due to post-hepatic obstruction. The incubation period is about 15 to 30 days.

Complications. These include hæmorrhage into the skin, lungs or intestines, nervous phenomena, such as meningitis, encephalitis, polyneuritis, myelitis, and upper motor lesions of the pyramidal and striatal types. Death may result from progressive jaundice and coma, or from cirrhosis and œsophageal hæmorrhage.

Differential Diagnosis. In the pre-icteric stage infectious hepatitis must be distinguished from influenza, gastro-enteritis, sandfly fever, malaria, meningitis, acute appendicitis, enterica group infections or an alcoholic "hang-over." When jaundice appears, Weil's disease can be excluded by the leucocytosis and positive agglutination findings.

Treatment. Prophylactic. Human gamma-globulin, injected intramuscularly during the incubation period, appears to be of definite value in preventing or attenuating an attack. The dose is 0.02 to 0.04 ml. of 16% concentration per kg. body weight.

Curative. The patient should go to bed at the onset and remain there until the temperature is normal, the liver has returned to its accustomed size and is no longer tender, there are no symptoms such as lassitude and nausea, and the serum bilirubin has been normal for a week. The fæces and urine must be safely disposed of, as in typhoid fever. It is usually advised that the diet should contain about 120 G. protein, 200 to 300 G. carbohydrate and 40 to 50 G. fat, or more fat if the patient desires it. A light diet with plenty of milk from which the top layer of cream has been removed, is usually suitable. Fluids up to 5 pints (3 litres) a day should be taken during the acute stages. For nausea or vomiting promethazine chlorthephyllinate (Avomine) 25 mg. may be given before meals. For hæmorrhage vitamin K should be injected intramuscularly in doses of 5 mg. daily, and for serious hæmorrhage a blood transfusion should be given. In severe cases of hepatitis prednisone should be given by mouth in doses of 5 mg. tab. t.i.d. for a few weeks. In very acute cases with hepatic coma hydrocortisone, 200 mg., should be injected intravenously daily. No alcohol should be allowed for a year.

Homologous Serum Jaundice

Definition. Jaundice resulting from the introduction into man of human blood, serum or plasma containing virus B.

Etiology. It was suggested that homologous serum jaundice was

controlled by means of alkalis, dextrose and insulin. The dextrose can be given by mouth, $\frac{1}{2}$ to 1 lb. (240 to 480 G.) daily in a quart (1.2 litre) of orangeade, or by rectal injections of 4 to 8 fl. oz. (120 to 240 ml.) of normal saline containing 5% dextrose, every 4 to 6 hours, or by intravenous drip of 1 to 2 pints (0.6 to 1.2 litre) of normal saline, containing 5% dextrose, with 5 to 10 units of insulin twice a day. Sod. bicarb. 60 to 120 gr. (4 to 8 G.) should be given by mouth every 24 hours. Plenty of fluids in addition should be taken such as water and barley water, and $\frac{1}{2}$ to 1 pint (300 to 600 ml.) of milk daily. Amino-acid intravenous injections, in the form of protein hydrolysates, are worthy of a trial, given as a solution of 5% casein hydrolysate, at the rate of 40 drops a minute, each pint (600 ml.) being alternated with 500 ml. of 5% dextrose solution in distilled water or normal saline, according to the chloride output in the urine. The bowels should be kept open daily with salines, such as mag. sulph. 60 to 120 gr. (4 to 8 G.) *mane*, or with enemata. For insomnia and restlessness, bromides 10 to 30 gr. (0.6 to 2 G.) *t.d.s.* should be given. Morphine must not be administered owing to the risk of toxic effects.

Hepatic Coma

This is a rare complication of hepatic failure, but it is also sometimes met with after portacaval anastomosis, in which the liver is short-circuited. It is considered to be due to failure of the liver to metabolise nitrogenous substances absorbed from the intestines, and in some, but not in all cases, there is a high blood ammonium level.

The exciting cause is thought to be an excessive intake of protein, or the administration of methionine, choline or ammonium chloride.

Clinical Findings. Hepatic coma is characterised by the following features: A far-away look in the eyes, untidiness, mental confusion, generalised tremors, apraxia on dressing, muscular rigidity, exaggerated deep reflexes, ankle clonus, and later coma. In addition the breath may have a sweet or slightly faecal odour, the so-called *fœtor hepaticus*, and on asking the patient to hold out the arms with the fingers separated, a flapping tremor may be noted, in which there are periodic movements of flexion and extension at the wrist and metacarpo-phalangeal joints. Flapping tremor may also occur in pulmonary insufficiency, renal failure, polycythæmia vera, severe malnutrition and steatorrhœa.

Hepatic coma is of grave significance in infectious hepatitis, but in cirrhosis hepatitis it may assume a chronic form.

Treatment. In an acute attack no nitrogenous food must be given, and the patient should be fed on dextrose and fruit juices. If he cannot swallow, a 20% solution of dextrose should be given by intragastric drip, 8 to 5 pints (1.8 to 3 litres) in the 24 hours, with the addition of 2 G. of potassium chloride. After a few days a high carbohydrate, low protein diet can be given, with a little fat. The protein can then be increased to 20 G. on alternate days. Morphine and barbiturates must not be prescribed to control restlessness, but paraldehyde 60 to 120 m. (4 to 8 ml.) can be given by mouth, or 300 m. (2½ ml.) of paraldehyde in 8 fl. oz. (90 ml.) normal saline may be injected into the rectum. Neomycin

in association with chemical poisons, such as chloroform, neoarsphenamine, alcohol, phosphorus, trinitro-toluene and tetrachlorethane. A few cases have resulted from the therapeutic administration of Atophan. A case has been recorded after a prolonged Trilene anæsthetic, death occurring 11 days later. It is also met with in pregnancy and occasionally in such diseases as typhoid fever and influenza. It has been shown experimentally that necrosis of the liver can be produced by certain poisons of chemical origin (toxipathic hepatitis), or by lack of a nutritive factor contained in protein (trophopathic hepatitis). *Predisposing causes*: 1. Age: The majority of cases occur between the ages of 20 and 40, but it may develop at any age. 2. Sex: In adult life females predominate.

Pathology. At autopsy the liver is small, greenish in colour and the capsule is wrinkled. On section it is soft and yellow, due to excess of bile, and red areas caused by extravasated blood or hæmangiomata may be present. The changes are necrotic rather than atrophic, and begin in the periphery or centre of the lobules. In cases showing a tendency to recovery, nodular hyperplasia of liver cells may be found and the necrotic areas may be replaced by fibrous tissue. The spleen may be enlarged and soft, and meningeal hæmorrhages may be present.

Clinical Findings. The patient may be a pregnant woman, who is taken ill with symptoms resembling those of infectious hepatitis. In about 5 or 6 days, however, her condition becomes very much worse, the jaundice deepens, vomiting becomes intractable, and headache is severe.

On Examination: The patient is restless, muscular twitchings may be seen, and the tongue is brown and dry. The breath has a fishy odour. The area of liver dulness is diminished, and it may be completely obliterated. The pulse is rapid, and the temperature is usually about 99° or 100° F. (37·2° or 37·8° C.). The pupils are often dilated, and the plantar response may be extensor. The bowels are constipated and the motions clay-coloured. Hæmorrhages may occur from various sites, such as the stomach, intestines, kidneys, or under the skin. The urine is dark, containing bile pigments and usually protein and casts. Leucine and tyrosine crystals are also present. The blood shows a low alkali reserve, owing to the acidosis. It gives an immediate direct van den Bergh reaction.

Differential Diagnosis. At the onset the case resembles one of infectious hepatitis, but in a few days it is obvious that the patient is gravely ill. Acute hepatic necrosis may then be confused with spirochætal jaundice, but the liver is not diminished in the latter disease. In phosphorus poisoning also the liver is usually normal in size or somewhat enlarged.

Course and Complications. In severe cases the patient soon becomes delirious and comatose. The temperature may rise rapidly to 106° F. (41° C.) or higher just before death. In milder cases a subacute phase follows.

Prognosis. Death usually occurs in about 2 weeks in acute cases, in subacute cases it may be delayed for several weeks. Recovery may occur in the milder types of the disease.

Treatment. The patient must be kept quiet in bed, and the acidosis

be palpable. In other cases, where there is ascites, it may not be possible to feel the liver until the fluid has been removed. The spleen is usually not enlarged. Jaundice is not present in every case, but when it occurs it is usually obstructive in type and progressive. In addition to the ascites, in the later stages there is œdema of the feet, and dilated veins are seen in the lower part of the abdomen. A mass of growth may be felt near the umbilicus, and enlarged lymph nodes may be present elsewhere, according to the general dissemination. There is usually a microcytic anæmia. The temperature is often irregularly raised.

Differential Diagnosis. This is usually quite clear when the primary growth can be detected. In other cases, such causes of hepatic enlargement as cirrhosis of the liver, gummatosis, amyloid degeneration, an abscess or hydatid cyst, a stone in the common bile duct, etc., must be considered. The Wassermann reaction should always be determined, and if found positive a course of anti-syphilitic treatment should be given.

Course and Complications. The patient becomes progressively more ill, and finally dies, in the majority of cases with cholæmic symptoms. There may be hæmorrhages in the skin, and cholangitis may occur as a complication.

Prognosis. Death generally takes place within a year from the diagnosis.

Treatment. This is only palliative. In some cases there is no pain, in others it is very severe. Relief can be obtained by aspirin 10 gr. (0.6 G.) t.d.s. by mouth, by *Nepenthe* 10 to 20 m. (0.6 to 1.2 ml.) t.d.s. by mouth, or by subcutaneous injections of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) or of pethidine hydrochlor. 100 mg. as required.

Primary Sarcoma

This may form a single large tumour, or be found as multiple nodules, or as a diffuse growth. It is very rare.

Secondary Sarcoma

The sarcoma is secondary to sarcoma of the adrenals, the mediastinum, the skin, a bone or the uveal tract in the eye. With melanotic sarcoma, melanin may be found in the urine, and the primary growth is in the skin or the eye.

Hodgkin's Disease

This disease is more fully described on p. 542. When the liver is involved it is slightly enlarged, and ascites or jaundice may develop. The liver is firm and whitish in colour, the lymphogranulomatous tissue being spread throughout its substance.

Amyloid Liver

Etiology. Amyloid liver occurs in association with chronic pulmonary tuberculosis, syphilis and long-standing cases of suppuration of the bones. It is comparatively rarely seen.

sulph. (Nivemycin), 500 mg., should be given to reduce bacterial activity in the intestines, the initial dose being 2 G., followed by 1 G. four-hourly for 7 days.

Tumours of the Liver

Simple and malignant tumours may arise in the liver. The simple tumours include an adenoma, angioma and teratoma. The adenoma may be sufficiently large to be felt during life. An angioma usually gives rise to no symptoms or signs, and is discovered at autopsy, but occasionally spontaneous rupture occurs with intraperitoneal hæmorrhage. Teratomata are rare. The malignant tumours are either primary or secondary carcinoma or sarcoma. The majority of cases are secondary carcinoma.

Primary Carcinoma

Pathology. The following varieties are described: A large growth (hepatoma), distending the liver substance; smaller secondary deposits may occur in the liver. A diffuse growth which may be scirrhus. A multiple nodular growth. Cirrhosis carcinomatosa, in which the carcinoma probably develops in association with hepatic cirrhosis. Secondary deposits may be found in lymph nodes, the lungs, brain, bones, etc.

Clinical Findings. The onset is insidious, the patient complaining of progressive weakness, with perhaps pain in the region of the liver. Frequently the tumour is not sufficiently large to be felt. There may be a continuous unexplained fever of 100° to 101° F. (37.8° to 38.3° C.) for weeks, with severe night sweats. The sedimentation rate of the red cells is high. There is usually no jaundice and often no ascites, but the patient rapidly goes down hill, and death occurs in a few months from the onset of the symptoms.

Secondary Carcinoma

Pathology. At autopsy the liver is enlarged, and numerous deposits of whitish growth can be seen on the surface and on section. The projections may be umbilicated in the centre, owing to necrosis. Perihepatitis may be present in association with the nodules. The peritoneum may also be involved, with ascites. Dissemination to the liver is by the blood stream, but with a primary growth in the breast the spread occurs by lymphatic permeation. The primary growth is most frequently found in the stomach, then in the colon and rectum, the œsophagus, pancreas, gall-bladder, uterus, breast, lungs, etc.

Clinical Findings. The patient is most commonly a woman over the age of 40. There may be a definite history pointing to a carcinoma of the stomach, rectum or breast, or the first symptoms arousing attention may be hepatic in origin. In such a case it may be difficult to detect the site of the primary growth. The patient may complain of pains in the region of the liver, in the back, or down the arms. The skin may also itch very violently, although there is no icterus.

On Examination: The abdomen is usually distended, whereas the body generally is wasted and the patient appears cachectic. The liver may be felt much enlarged, and the umbilicated nodules on its surface may

to glycogen retention. Acetone may be detected in the breath and urine. There is no glycosuria. In older children there may be evidence of infantilism. The blood sugar is low, and does not rise over 80 mg. per 100 ml. in half an hour after the injection of 1 ml. of adrenaline. The blood glycogen and cholesterol are raised.

Differential Diagnosis. The absence of splenomegaly excludes Gaucher's disease and the Neimann-Pick disease. Neuro-blastoma of the adrenal with secondary deposits in the liver is rapidly fatal. The negative Wassermann reaction excludes syphilis. It may be impossible to distinguish von Gierke's disease from hypertrophic steatosis of the liver, without a microscopical examination of a portion of the liver, obtained by liver puncture or by excision.

Course and Complications. The course is often prolonged, but the child may eventually recover, with return of the liver to its normal size, although some degree of acetonuria is liable to persist.

Prognosis. If death does not occur from intercurrent infections, such as enteritis or pneumonia, there is a good prospect of recovery.

Treatment. No special treatment is available.

The Leukæmic Liver

Etiology. The liver is usually affected in lymphatic leukæmia, but less often in the myeloid type.

Clinical Findings. In addition to the general and local effects of the leukæmia, the liver is enlarged but painless. There is usually no ascites, but jaundice may be present.

Tuberculosis of the Liver

Pathology. The tubercle bacilli may gain access to the liver before birth by the umbilical vein, or after birth through the hepatic artery, portal vein, or rarely by lymphatics. The lesions may be miliary, with pericellular cirrhosis, or localised caseous nodules may be found.

Clinical Findings. It is not usually possible to diagnose hepatic tuberculosis during life although aspiration liver biopsy may reveal the condition.

Syphilis of the Liver

Pathology. The lesions may be congenital or acquired. *Congenital syphilis*: The liver shows pericellular cirrhosis, and in the late congenital type there may be gummata with fibrosis. *Acquired syphilis*: There may be hepatitis during the secondary stage, and later multiple gummata may be found. The gumma undergoes central necrosis, fibrous tissue forms around it, which on contraction and healing leaves a depressed scar (*hepar lobatum*). A multilobular cirrhosis may also occur.

Clinical Findings. In congenital syphilis the associated lesions are found elsewhere. The spleen and liver are both usually enlarged and firm. There is generally no ascites and often no jaundice. In late congenital syphilis the enlargement and irregularity of the liver may not be manifest until after the age of 10 years. In acquired syphilis

Pathology. The liver is enlarged, firm and smooth. It is tough to cut and pale on section. The amyloid degeneration is seen in the walls of the capillaries, especially in the intermediate zone of the lobules.

Clinical Findings. *On Examination:* The patient presents the signs of the disease which has led to the amyloid degeneration, such as long-standing pulmonary tuberculosis. The liver is enlarged and feels smooth and firm. There is no pain over the liver. Ascites is not common.

Differential Diagnosis. The firm character of the liver helps to differentiate it from the painless enlargement met with in fatty degeneration. Other evidences of amyloid degeneration may be found, such as proteinuria, diarrhoea and enlargement of the spleen.

Prognosis. This is grave, and amyloid degeneration is often the precursor of death.

Treatment. This is directed to the causative condition.

Fatty Liver

Etiology. Fatty changes in the liver may be due to generalised obesity, chronic alcoholism, nutritional deficiencies, chemical substances such as phosphorus, severe anæmias, acidosis in diabetes mellitus or cyclical vomiting, and in some cases to tuberculosis.

Pathology. The degenerating liver cell contents are not converted into fat. The fatty changes may be due to lack of thiamine or of the lipotropic factor. In most cases there is transfer of fat from the tissue depots to the liver. The liver is enlarged and greasy on section.

Clinical Findings. These vary with the causative factor. The liver is often difficult to feel, owing to its softness or to the obesity of the patient. It does not cause pain.

Treatment. This must depend upon the nature of the causative condition.

Von Gierke's Disease

(*Hepatomegalia Glycogenica, Glycogen Disease*)

Definition. A disease of children characterised by enlargement of the liver, acetonuria and hypoglycæmia.

Etiology. The disease results from a metabolic error which is probably congenital, and is possibly due to the lack of a glycogen-splitting ferment.

Pathology. The liver is enlarged, due to excess of glycogen. The kidneys also, and in some cases the heart and voluntary muscles, may show an accumulation of glycogen.

Clinical Findings. The patient is usually a young child who is brought to the doctor on account of swelling of the abdomen or attacks of faintness.

On Examination: The liver is much enlarged, smooth and moderately firm. The spleen is not enlarged. Distended abdominal veins may be seen, but there is no ascites. The heart is sometimes enlarged owing

Acute Catarrhal Cholecystitis

Pathology. The wall of the gall-bladder is inflamed, and adhesions may extend externally from its serous coat. The mucous membrane is swollen. The contents are clear, turbid, or bile- or blood-stained fluid, and gall-stones may be present. The orifice of the cystic duct may be blocked by the swelling of the mucous membrane.

Clinical Findings. The patient complains of severe pain in the region of the gall-bladder. Rarely the gall-bladder is situated in the left of the abdomen (see Fig. 10). The pain may be paroxysmal and colicky in nature or a more continuous ache; it may radiate all over the abdomen, and to the right scapular region. There may be intense nausea and vomiting.

On Examination: The right upper rectus muscle is on guard, and tenderness is elicited over the gall-bladder. If there is cystic obstruction it may be possible to feel the distended gall-bladder. The temperature may be normal or slightly raised. Usually there is no jaundice.

Differential Diagnosis. It is impossible to eliminate with certainty the presence of gall-stones, but in biliary colic due to calculi the pain is of a more excruciating nature. An appendix abscess may closely simulate acute cholecystitis, but the swelling in the former is usually lower in the abdomen. With suppurative cholecystitis the constitutional disturbance is generally greater, the temperature is higher, and there may be sweating and rigors. In pyelonephritis the typical urinary changes are found.

Course and Complications. An acute attack may rapidly subside, but recurrence is not uncommon. Complications include suppurative cholecystitis which may pass on to gangrene, and perforation of the gall-bladder. Sequelæ include the formation of external adhesions, which may produce pyloric obstruction, and the development of chronic cholecystitis and gall-stones.

Prognosis. This is always uncertain.

Treatment. The patient should be kept in bed, and pain relieved by the application of hot flannels over the gall-bladder. It may be necessary to inject subcutaneously morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.) or pethidine hydrochlor. 100 mg. if the pain is very severe. The bowels should be opened and the gall-bladder encouraged to empty itself by giving mag. sulph. 60 to 120 gr. (4 to 8 G.) in hot water, 2 fl. oz. (60 ml.) every morning. A course of chlortetracycline (Aureomycin) or penicillin should be given. The dosage of chlortetracycline (Aureomycin) is detailed on p. 155. Penicillin should be injected intramuscularly in doses of 600,000 units of a procaine preparation morning and evening for 6 to 7 days. The diet must be fluid during the acute stage, such as milk and soda, and meat extracts. Operation is required in cases of suppuration.

Subacute Cholecystitis

(*Lipid Cholecystitis. Cholesterosis. "Strawberry Gall-bladder"*)

Pathology. The gall-bladder is usually normal externally, but the cystic lymph node is enlarged. Yellowish-white spots are dotted all over

of the liver there is often pain due to perihepatitis, and a firm nodular liver is present. The Wassermann reaction is positive.

Treatment. In congenital syphilis the treatment is as described on p. 598, and in acquired syphilis as described on p. 600.

Actinomycosis of the Liver

Etiology. The cause is the *Actinomyces bovis* (*Streptothrix actinomyces*) (see p. 607).

Pathology. The liver is usually infected secondarily to actinomycosis of the intestine. The lesion presents a honeycomb appearance and is bright yellow. There is often associated perihepatitis. The infection may spread directly to the pleura or lung, into the peritoneum, or work its way through the abdominal wall.

Clinical Findings. The patient complains of ill-health and malaise with fever. In addition, there may be pain in the region of the liver.

On Examination: The liver is palpable and tender, and the surface may be irregular. The blood shows a leucocytosis. If the actinomycotic lesion ulcerates through the abdominal wall, the streptothrix will usually be found in the pus.

Prognosis. This is very grave.

Treatment. Benzylpenicillin, 1,000,000 units (600 mg.), should be injected intramuscularly every 6 hours for about 6 weeks.

THE GALL-BLADDER

Acute Cholecystitis

Definition. Acute inflammation of the gall-bladder.

Etiology. The inflammation results from bacterial infection. The organisms most often found are the *E. coli*, the *Salmonella typhi*, streptococci and staphylococci. Less frequently the *Streptococcus pneumoniae* (pneumococcus), the *Pseudomonas pyocyanea* (*B. pyocyaneus*) or anaerobes such as the *Clostridium welchii* (*B. welchii*) may be present. **Predisposing causes:** 1. Age: Usually over 40 years. 2. Sex: Females predominate. 3. Constitution and habits: Obesity, a sedentary life, and constipation. 4. Previous illness: Especially typhoid fever and gall-stones.

Pathology. The organisms may reach the gall-bladder by various routes. The blood: Non-hæmolytic streptococci may gain access to the gall-bladder by the cystic artery, coming from a distant focus in the tonsils or teeth. The intestines: The organisms are conveyed by the portal vein. The bile duct: The organisms, such as the *Salmonella typhi*, may ascend to the gall-bladder against the bile stream. The lymphatics: The organisms may pass from the liver to the gall-bladder.

Streptococci have been found in the submucous tissue of the gall-bladder (mural cholecystitis) and in the cystic lymph node in a high percentage of cases, when they have not been present in the mucous membrane or in the contents of the gall-bladder. These are presumably organisms which have been carried by the blood from a distant focus. The following varieties of acute cholecystitis are described: Catarrhal, suppurative, phlegmonous, gangrenous and membranous.

Treatment. If gall-stones are present, or if there is evidence of chronic appendicitis, the gall-bladder and appendix should be removed. In other cases an attempt should be made to disinfect the contents of the gall-bladder by means of hexamine, which, in the presence of bile, is potent in an alkaline medium. Two mixtures are ordered, Hexamine 100 gr. (6 G.), aq. ad 1 fl. oz. (30 ml.), and Pot. cit. and sod. cit. āā 100 gr. (6 G.), aq. ad 1 fl. oz. (30 ml.). The patient begins the course with 60 m. (4 ml.) of the hexamine mixture and 1 fl. oz. (30 ml.) of the alkaline mixture after breakfast, tea, and after a glass of milk or water last thing at night. The hexamine mixture is increased by 60 m. (4 ml.) daily until the patient is taking 1 fl. oz. (30 ml.), i.e. 100 gr. (6 G.), t.i.d. The urine should be tested 3 times a day, as unless an alkaline reaction is maintained there is a risk of producing vesical irritability and hæmaturia. This dose is continued for 5 to 6 weeks when the symptoms should have disappeared. On waking, mag. sulph. 30 to 120 gr. (4 to 8 G.) should be taken in 2 fl. oz. (60 ml.) of hot water, an hour before breakfast, and the patient should then lie on the right side. This should cause the gall-bladder to contract. The amount of mag. sulph. taken is regulated by its effect on the bowels, as it is not desired that there should be diarrhoea. It is doubtful whether the sulphonamides or penicillin reach the gall-bladder in sufficient amounts to produce a bacteriostatic effect if the cystic duct is blocked, but a course of tetracycline may be tried, 250 mg. q.i.d. for 4 weeks. There is no necessity to give a fat-poor diet if there is no evidence of cholelithiasis.

Chronic Empyema of the Gall-bladder

This may be a sequel of acute cholecystitis. The patient complains of pain and tenderness in the region of the gall-bladder, which may be palpable. There is usually no fever.

Torsion of the Gall-bladder

This is a rare condition resembling clinically an acute abdominal emergency. It may result in gangrene of the gall-bladder. Treatment consists in cholecystectomy.

Parasitic Infections of the Gall-bladder

These are rare. At times the *Ascaris lumbricoides*, *Giardia lamblia*, *Echinococcus granulosus* (*T. echinococcus*) or the *Distoma hepaticum* may be present in the gall-bladder.

Tumours of the Gall-bladder

Simple Tumours. These are rare and cannot usually be diagnosed. They include papilloma, adenoma and fibroma.

Malignant Tumours. These include primary and secondary carcinoma and sarcoma. The majority of cases are primary carcinoma.

Primary Carcinoma of the Gall-bladder

Etiology. The cause is not known, but the growth is often associated with gall-stones or chronic cholecystitis. Other predisposing causes

the mucous membrane. These are due to deposition of lipid (cholesterolester) in the cells of the mucosa. Mulberry cholesterin stones may be present. Streptococci are usually found in the submucous tissue and in the cystic lymph node.

Clinical Findings. The symptoms closely resemble those of catarrhal cholecystitis, but are of a milder degree than those described under the acute catarrhal infection.

Treatment. The gall-bladder should be removed.

Chronic Cholecystitis

Etiology. Chronic cholecystitis is due to infection with similar types of organisms as described for acute cholecystitis. It may develop insidiously or follow an acute attack.

Pathology. The wall of the gall-bladder is often thickened, with external adhesions. In some cases, if a calculus is occluding the cystic duct, the gall-bladder is distended. Calculi are often present and the cystic lymph node is enlarged.

Clinical Findings. The patient complains of chronic indigestion, the chief features of which are flatulence and epigastric distention after meals and periodical attacks of nausea or vomiting. Pain may be felt also in the region of the gall-bladder or in the epigastrium, and may radiate around the chest and pass to the right scapular region. There may be slight icterus with fever from time to time.

On Examination : The right upper rectus is usually slightly rigid as compared with the left. On palpation in the region of the gall-bladder the patient may experience pain on taking a deep breath, and the breathing may be suddenly checked (Murphy's sign). This may be best elicited if the patient is examined standing and bending slightly forward. A cholecystogram may show that the gall-bladder does not fill or contract normally, or the gall-bladder when thus visualised by the X-rays may be found to be tender on palpation. There may be achlorhydria.

Differential Diagnosis. Chronic cholecystitis may be confused with a gastric or duodenal ulcer, with gall-stones, with chronic appendicitis, or with angina pectoris. The pain referred from arthritis of the spine is also misleading. The opaque meal affords valuable indication as to the presence of a gastric or duodenal ulcer. Gall-stones may be shown by direct X-ray or by the cholecystogram, but they are usually associated with chronic cholecystitis.

Chronic appendicitis also may be present with chronic cholecystitis, but in chronic appendicitis palpation over the appendix when visualised by X-rays usually causes pain. An X-ray examination of the mid-thoracic spine will exclude arthritis.

Course and Complications. Chronic cholecystitis, unless adequately treated, is usually a progressive lesion. An attack of acute cholecystitis may occur at any time. Complications include the formation of gall-stones with biliary colic, pancreatitis, arthritis, phlebitis and myocardial degeneration.

Prognosis. Chronic cholecystitis is a cause of persistent ill-health, but is not usually a fatal disease.

Treatment. If gall-stones are present, or if there is evidence of chronic appendicitis, the gall-bladder and appendix should be removed. In other cases an attempt should be made to disinfect the contents of the gall-bladder by means of hexamine, which, in the presence of bile, is potent in an alkaline medium. Two mixtures are ordered, Hexamine 100 gr. (6 G.), aq. ad 1 fl. oz. (30 ml.), and Pot. cit. and sod. cit. āā 100 gr. (6 G.), aq. ad 1 fl. oz. (30 ml.). The patient begins the course with 60 m. (4 ml.) of the hexamine mixture and 1 fl. oz. (30 ml.) of the alkaline mixture after breakfast, tea, and after a glass of milk or water last thing at night. The hexamine mixture is increased by 60 m. (4 ml.) daily until the patient is taking 1 fl. oz. (30 ml.), i.e. 100 gr. (6 G.), t.i.d. The urine should be tested 3 times a day, as unless an alkaline reaction is maintained there is a risk of producing vesical irritability and hæmaturia. This dose is continued for 5 to 6 weeks when the symptoms should have disappeared. On waking, mag. sulph. 30 to 120 gr. (4 to 8 G.) should be taken in 2 fl. oz. (60 ml.) of hot water, an hour before breakfast, and the patient should then lie on the right side. This should cause the gall-bladder to contract. The amount of mag. sulph. taken is regulated by its effect on the bowels, as it is not desired that there should be diarrhoea. It is doubtful whether the sulphonamides or penicillin reach the gall-bladder in sufficient amounts to produce a bacteriostatic effect if the cystic duct is blocked, but a course of tetracycline may be tried, 250 mg. q.i.d. for 4 weeks. There is no necessity to give a fat-poor diet if there is no evidence of cholelithiasis.

Chronic Emphyema of the Gall-bladder

This may be a sequel of acute cholecystitis. The patient complains of pain and tenderness in the region of the gall-bladder, which may be palpable. There is usually no fever.

Torsion of the Gall-bladder

This is a rare condition resembling clinically an acute abdominal emergency. It may result in gangrene of the gall-bladder. Treatment consists in cholecystectomy.

Parasitic Infections of the Gall-bladder

These are rare. At times the *Ascaris lumbricoides*, *Giardia lamblia*, *Echinococcus granulosus* (*T. echinococcus*) or the *Distoma hepaticum* may be present in the gall-bladder.

Tumours of the Gall-bladder

Simple Tumours. These are rare and cannot usually be diagnosed. They include papilloma, adenoma and fibroma.

Malignant Tumours. These include primary and secondary carcinoma and sarcoma. The majority of cases are primary carcinoma.

Primary Carcinoma of the Gall-bladder

Etiology. The cause is not known, but the growth is often associated with gall-stones or chronic cholecystitis. Other predisposing causes

include:—1. Age: Usually over 45. 2. Sex: Females predominate in the proportion of about 4 to 1.

Pathology. The growth may be papillomatous and fungating, or diffuse and infiltrating. It is most often situated at the fundus. It may spread directly to the liver, into the bile ducts, or form a sinus through the abdominal wall or a fistula into the colon. It may perforate intraperitoneally. Thrombosis of the portal vein may be found, and secondary deposits in the liver, or in lymph nodes in the portal fissure, above the clavicles, or in the anterior mediastinum. Microscopically the growth may be columnar or spheroidal celled and colloid changes may be present.

Clinical Findings. The patient is often a woman over the age of 45, who gives a history suggestive of chronic cholecystitis or gall-stones. More recently she has noticed increasing discomfort or pain in the region of the gall-bladder, with loss of strength.

On Examination: In the early stages nothing may be found, but later the gall-bladder is palpable, tender, and the surface is often irregular. The liver may also be enlarged. If there is pressure on the bile ducts either from the growth or from the enlarged portal lymph nodes, there will be obstructive jaundice. There may also be ascites and swelling of the legs. Enlarged lymph nodes may be felt above the clavicles. In the later stages cachexia is more marked, and hæmorrhages may be seen under the skin. A cholecystogram may reveal a filling defect in the gall-bladder.

Differential Diagnosis. In the early stages the symptoms usually suggest cholecystitis or cholelithiasis. Later it is often difficult to differentiate carcinoma of the gall-bladder from a growth in the liver, pancreas or bile ducts. An opaque meal should serve to exclude carcinoma of the stomach.

Course and Complications. The course is usually rapidly progressive. Such complications as perforation, fistula formation or suppurative cholangitis may occur.

Prognosis. The disease is usually fatal within 8 months from the onset of symptoms.

Treatment. This is only symptomatic and palliative, as operative removal of the growth is usually impossible.

Secondary Carcinoma of the Gall-bladder

The gall-bladder may be affected secondarily by direct spread from a growth of the stomach or colon, or by metastases from growths elsewhere. These deposits are usually subperitoneal.

Gall-stones (Cholelithiasis)

Definition. Calculi formed in the biliary passages or gall-bladder.

Etiology. The main factors in their formation are: Infection, biliary stasis, and hypercholesterolaemia. *Predisposing causes:* 1. Age: Usually over 40. 2. Sex: Females predominate. 3. Habits: A sedentary life and over-eating. 4. Associated conditions: Pregnancy, chronic

diseases of the heart or lungs, constipation. 5. Climate : Especially the temperate zones. 6. Heredity: There is a familial tendency. Small pigment stones may form in the young in association with hæmolytic anæmia.

Pathology. Frequently cholecystitis precedes the formation of calculi. A central nucleus consisting of organisms (not infrequently anaerobes), mucus or fibrin may be the starting-point. The bile in the gall-bladder, especially if stagnant, may be unduly rich in pigment, cholesterol or lime salts. The gall-bladder wall is frequently infected, even when its contents are sterile. Thus in a series of cases of gall-stones, the gall-bladder was infected in 70%, the fluid contents in 40% and the stones in 80% of the cases. Aseptic calculi are thought to occur apart from infection, especially when the blood cholesterol is high, as in pregnancy and in some cases of obesity and arteriosclerosis. A solitary calculus may be found, or as many as 14,000 stones may be present in the gall-bladder. The stones may be situated in the cystic duct, or less commonly in the common bile duct and the extra- or intra-hepatic ducts.

Varieties. 1. The pure cholesterol stone. This is usually solitary, oval or circular, pale and very light. It may be formed apart from sepsis.

2. The laminated cholesterol stone containing layers of cholesterol and calcium bilirubin.

3. Mixed gall-stones containing cholesterol (80% to 98%) and calcium bilirubin. These are soft before they are dried.

4. Pure calcium bilirubin (mulberry stones). Small hard irregular stones.

5. Calcium carbonate. These stones are rare.

Clinical Findings. In some cases stones in the gall-bladder give rise to no symptoms, and are only demonstrated post-mortem. In other cases the symptoms are those described above as being typical of chronic cholecystitis. If the stone becomes impacted in the cystic duct, the gall-bladder enlarges and is painful, but there is no jaundice. When the calculus enters the common bile duct, biliary colic usually ensues. According to Courvoisier's law, the gall-bladder is usually not distended in cases of jaundice due to a calculus in the common bile duct, owing to the presence of old cholecystitis, whereas in obstruction of the common bile duct due to a growth the gall-bladder is dilated. In some cases there is persistent jaundice without pain. If the stone is lodged in the hepatopancreatic ampulla (ampulla of Vater) forming a ball-valve obstruction, there are usually periodical attacks of fever and jaundice, known as the *intermittent hepatic fever of Charcot*.

Biliary Colic. This may occur when the stone enters one of the biliary passages. The onset of the symptoms is often sudden, occurring frequently during the night. The patient complains of excruciating pain which radiates all over the abdomen to the right scapular region and tip of the right shoulder. It is paroxysmal, the patient rolls about or doubles up in agony. There is sweating and often vomiting. Attacks of biliary colic not due to a gall-stone are described. These may occur after cholecystectomy. They are thought to be due to

achalasia of the sphincter of Oddi, but in some instances are due to pancreatitis.

On Examination: It is not usually possible to feel the gall-bladder, but the right upper rectus is somewhat rigid. The temperature may be normal or slightly raised. The pulse is feeble, but is not increased in rate. Jaundice may be noted a day or so after the attack, and stones may be found in the faeces. Whether or not gall-stones can be seen by X-rays depends upon their calcium content. A cholecystogram may reveal their presence as a lighter shadow in the opaque gall-bladder when they are not demonstrable in a direct radiogram (see Fig. 11).

Differential Diagnosis. Biliary colic must be differentiated from renal, pancreatic or intestinal colic, hiatus hernia, a tabetic crisis associated with colic and jaundice, the pain of coronary thrombosis, of acute pancreatitis or perforation of a gastric or duodenal ulcer. The excruciating paroxysmal pain with its characteristic distribution usually serves to differentiate.

Course and Complications. The attack may last from a few minutes to a few hours. Recurrences are liable to occur. Complications include perforation of the gall-bladder, ulceration into the small intestine with subsequent intestinal obstruction, formation of various fistulae such as a gastric, duodenal, intestinal, colic, or bronchial fistula, or a cutaneous sinus. Suppurative cholangitis or liver abscess may also ensue. Intestinal volvulus, acute or chronic pancreatitis, or carcinoma of the gall-bladder or bile ducts may follow.

Prognosis. Death during an attack is rare, but succeeding attacks are liable to occur, and gall-stones may form in the biliary passages after cholecystectomy.

Treatment. Prophylactic. Chronic cholecystitis should be treated as described above. If there is a tendency to hypercholesterolaemia, the diet should be fat-poor, and eggs should not be eaten.

Curative. During an attack of biliary colic the acute pain must be controlled either by the subcutaneous injection of morphine sulphate $\frac{1}{4}$ gr. (15 mg.) and atropine sulphate 1/100 gr. (0.6 mg.), by the subcutaneous injection of pethidine hydrochlor. 100 mg. or by the intravenous injection of atropine sulphate 1/100 gr. (0.6 mg.). Tab. glyceryl. trinitrat. 1/100 gr. (0.6 mg.) should be dissolved under the tongue at the same time as the morphine is injected. Milder attacks may be mitigated by a hot bath and by tnc. belladon. 30 m. (2 ml.), repeated in an hour if necessary. Subsequently the gall-bladder may be removed, or the patient may receive a course of treatment as for chronic cholecystitis. There is no known method of dissolving gall-stones.

The Post-cholecystectomy Syndrome

After cholecystectomy for gall-stones symptoms persist, or develop, in about 25% of patients, and in a higher percentage after removal of the gall-bladder for other causes. The pain, nausea and intolerance to certain foods, may be due to calculi in the ducts, inflammation of the gall-bladder stump, cholangitis, hepatitis, pancreatitis, adhesions, biliary dyskinesia, or to an error in diagnosis before operation, the pain

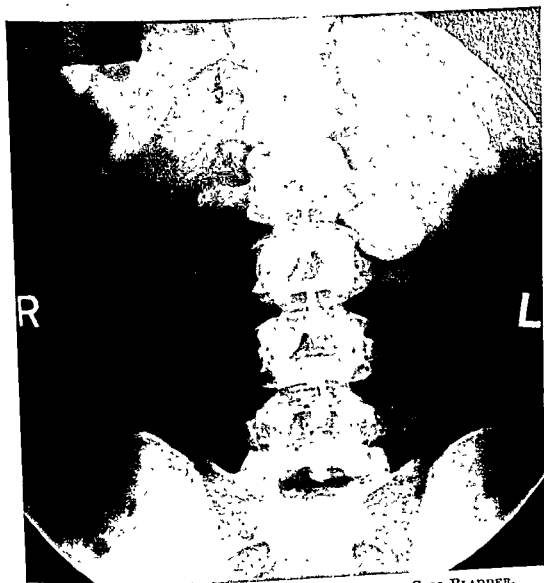


FIG. 10. CHOLECYSTOGRAM SHOWING LEFT-SIDED GALL-BLADDER.



FIG. 11. CHOLECYSTOGRAM SHOWING MANY RADIOLUCENT GALL-STONES OF VARYING SIZE.

being due to some other cause such as a hiatus hernia, arthritis of the spine, etc. If the patient is not jaundiced, intravenous cholangiography, using a preparation such as Biligraphin, will often demonstrate the common bile duct, the right and left hepatic ducts, and some intra-hepatic ducts, and thus afford valuable aid in determining the condition of the biliary passages.

THE BILE DUCTS

Congenital Obliteration

This is often associated with cirrhosis of the liver, and jaundice is present either at birth or a few weeks later. The liver and spleen are usually palpable; bile pigment is present in the urine, but not in the stools. Hæmorrhages may occur in the skin, mucous membranes or internal organs. The condition is not syphilitic. Death usually occurs within a few weeks.

Congenital syphilitic stricture of the bile ducts is rare.

Suppurative Cholangitis

Etiology. Suppurative cholangitis may be associated with gall-stones, cholecystitis or obstruction of the extra-hepatic ducts by a tumour. It may occur as a complication of such diseases as pneumonia or typhoid fever, or be secondary to an abscess in the liver.

Pathology. Suppuration may be found in the extra-hepatic bile ducts and the gall-bladder. The liver is enlarged and numerous small abscesses may be present.

Clinical Findings. The chief features are fever with jaundice and rigors. The patient is very gravely ill and the liver is usually enlarged and tender.

Differential Diagnosis. It is often impossible to diagnose suppurative cholangitis from suppurative pyelephlebitis. It is distinguished from intermittent hepatic fever (see p. 111) by the intervals of comparative health in the latter disease.

Course and Complications. The disease is usually progressive. Complications include pancreatitis and pyæmia.

Prognosis. This is always very grave, and the disease is fatal when abscesses form in the liver.

Treatment. An operation may enable the extra-hepatic ducts to be drained.

Chronic Catarrhal Cholangitis

This may be associated with cholecystitis and gall-stones or occur as a sequela of hepatitis. The extra-hepatic ducts in these cases are usually affected. In cirrhosis of the liver the intra-hepatic ducts may be involved. Patients with recurrent cholangitis who are unsuited for operation should be given a four weeks' course of 250 mg. tetracycline q.i.d.

Calculi in the Bile Ducts

A description of the effects produced by calculi in the bile ducts is given on p. 111.

Tumours of the Bile Ducts

Simple Tumours. These include a papilloma, adenoma and fibroma. They are all rare.

Malignant Tumours. Pathology. Primary carcinoma of the extra-hepatic ducts appears in the following sites in this order of frequency : At the union of the common hepatic and cystic ducts ; at the lower end of the common bile duct ; in the common hepatic duct ; in the cystic duct. The gall-bladder is dilated, with growths in the cystic duct and in the common bile duct, but there is no jaundice in the former case. The growth may spread directly into the pancreas. In some cases the growth originates in the gall-bladder and spreads down the lumen of the bile duct.

Clinical Findings The patient is usually an adult male. The onset of the disease is often insidious with jaundice which becomes more intense, progressive weakness and irregular fever. There is usually no pain.

On Examination : The growth cannot be felt, but the gall-bladder may be palpable. Bile is usually present in the urine, and the fæces are pale. "Silver stools," resembling in colour aluminium paint, have been described in cases of carcinoma of the hepatopancreatic ampulla, chronic pancreatitis, and sprue.

Differential Diagnosis. It is often difficult to distinguish a tumour of the bile duct from carcinoma of the head of the pancreas, and, in other cases, from a stone blocking the cystic duct.

Course and Complications. The course is steadily progressive, and cholæmia occurs as a terminal phase.

Prognosis. The patient usually dies in a few months.

Treatment. An exploratory laparotomy is usually performed to establish the diagnosis, and in some cases it is possible to relieve the jaundice by means of cholecystenterostomy.

THE PERITONEUM

Acute Peritonitis

Definition. Acute inflammation of the peritoneum.

Etiology. Acute peritonitis results from bacterial infection. The causative organisms include streptococci, the *E. coli*, staphylococci, the *Mycobacterium tuberculosis*, the *Streptococcus pneumoniae* (pneumococcus), the *Neisseria gonorrhæe* (gonococcus), the *Klebsiella pneumoniae* (Friedländer's bacillus), the *Pseudomonas pyocyanea* (*B. pyocyaneus*), the *Salmonella typhi* and anaerobic organisms.

Pathology. The organisms usually reach the peritoneum from the alimentary tract, either through a spot of lowered resistance in the wall, or through an actual perforation. They may also gain access from the gall-bladder, a liver abscess, the uterus, or through the uterine (Fallopian) tubes. In some cases they may be blood-borne, or enter through a wound of the abdomen. Terminal peritonitis may occur in chronic nephritis. The peritonitis may be localised, as around the appendix

and in the pelvis, or diffuse. The inflammation may be fibrinous or exudative, and adhesions usually form after removal of the exudate. The exudate may be serous, purulent or hæmorrhagic, and contain gas. There is usually intestinal paralysis. Certain varieties are described, according to the primary infecting organism : Streptococcal, staphylococcal and coliform infections.

Clinical Findings. The patient is suddenly seized with agonising abdominal pain which increases in severity. He vomits, and the bowels may be freely opened at first, but soon are constipated.

On Examination : The patient is usually found lying on his back with his knees drawn up ; the breathing is shallow. Abdominal movement is absent over the affected part of the abdomen. The abdominal wall is rigid, either locally or generally, and tender to light touch. The abdomen becomes distended. The liver dullness may be diminished if gas has escaped from the alimentary tract. No intestinal movements can be detected with the stethoscope. The facial expression is drawn and anxious (*facies Hippocratica*). The temperature may be a little raised or subnormal, but the pulse is frequent and of small volume. The tongue becomes furred and dry. A leucocytosis occurs in the course of a few hours. Pneumococcal peritonitis occurs more often in girls than in boys.

Differential Diagnosis. Acute peritonitis may be mistaken for intestinal colic, obstruction or hæmorrhage, a ruptured tubal pregnancy, acute appendicitis without perforation, acute hæmorrhagic pancreatitis, mesenteric thrombosis, a tabetic crisis, or hysteria. The important features in acute peritonitis are the absence of abdominal movement, and the rigidity. These may, however, not be very evident in a case in which the peritonitis has been present for many hours. The temperature may also be subnormal. The pulse is a good guide, as it becomes progressively more frequent as the condition deteriorates, and the tongue becomes more dry.

Course and Complications. If untreated, death occurs in the course of a day or so with generalised peritonitis, but there may be a short period of temporary improvement which is deceptive. Localised peritonitis may become completely shut off by adhesions and heal spontaneously.

Prognosis. This has been much improved by the use of sulphonamides and antibiotics.

Treatment. Streptomycin, chloramphenicol (Chloromycetin) or chlortetracycline (Aureomycin) should be administered intravenously in doses of 500 mg. twice daily until gastro-intestinal intubation can be discontinued. It should then be given by mouth in doses of 500 mg. every 6 hours for about 5 days. Fluid and salt loss must be made good by continuous intravenous administration of saline. Ileus is relieved by intubation of the stomach or intestine, and operation is required to repair a perforated viscus.

Acute Tuberculous Peritonitis

Etiology. Acute tuberculous peritonitis is generally secondary to

tuberculosis of the abdominal lymph nodes, the intestines, or genital organs.

Clinical Findings. The onset may closely simulate that of typhoid fever, the patient being taken ill with headache, malaise and abdominal discomfort. The bowels are loose or constipated.

On Examination: The temperature is raised, but often the pulse is not proportionally frequent. The temperature assumes the continuous type, with morning falls and evening rises of a degree or so. Gradually the abdomen becomes distended, first with flatus and later fluid may be detected. Definite swellings due to matted omentum or lymph nodes may be felt.

Course and Complications. In a favourable case the temperature gradually falls to normal in the course of a few weeks; complications such as a pleural effusion, intestinal obstruction, tuberculous enteritis, etc., may occur.

Treatment. The patient must be kept in bed during the febrile stage. Streptomycin should be injected intramuscularly, 1 G. daily for 70 days, together with the oral administration of para-aminosalicylic acid and/or isoniazid (see p. 170). Paracentesis may be required if there is a considerable amount of fluid present.

Gonococcal Peritonitis

This is usually secondary to infection of the uterine tubes; less often it occurs as a complication of gonococcal epididymitis. The peritonitis is generally localised to the pelvis. A course of a procaine penicillin should be given, 600,000 units intramuscularly twice daily for 5 to 7 days.

Bile Peritonitis

This results from escape of bile, which may follow cholecystectomy, or be due to acute cholecystitis, and necrotic lesions in the bile duct consequent on carcinoma or calculus. In other cases the perforation may rapidly seal over and the peritonitis is then often due to rupture of a subserous duct on the liver surface associated with cholangitis. The extravasation may at first be retroperitoneal and cause severe pain between the shoulders. When it enters the peritoneal cavity, it causes an outflow of plasma, fall of blood pressure and shock. The mortality rate is about 70%. Adequate drainage affords the best hope of cure.

Subdiaphragmatic Abscess

(Subphrenic Abscess)

Definition. A localised variety of acute peritonitis, with suppuration between the liver and diaphragm.

Anatomy and Etiology. Six anatomical varieties are recognised according to the relation of the abscess to the hepatic ligaments: four of these varieties are intraperitoneal, and two are extraperitoneal (see Fig. 12).

1. *Right Anterior Intraperitoneal.* The pus collects between the right side of the diaphragm and the superior, anterior and right lateral surfaces of the right lobe of the liver. The infection is derived from an appendix abscess, a perforated gastric or duodenal ulcer, or from suppuration in the liver or bile ducts.

2. *Right Posterior Intraperitoneal.* (Cantlie's subhepatic pouch. Rutherford Morrison's kidney pouch.) The pus collects in a pyramidal space, which lies transversely beneath the right lobe of the liver, with its apex medially disposed, close to the epiploic foramen (foramen of Winslow). The infection originates in the appendix, and rarely from a perforated gastric or duodenal ulcer, from a liver abscess, or from suppuration in the thorax.

3. *Left Anterior Intraperitoneal.* The abscess lies between the left lobe of the liver and the diaphragm and anterior abdominal wall. The pus is derived from a perforated gastric or duodenal ulcer, or from a splenic, hepatic or pelvic abscess.

4. *Left Posterior Intraperitoneal.* The abscess is in the lesser sac of the peritoneum, the epiploic foramen (foramen of Winslow) being closed by adhesions. The abscess is derived from a perforated posterior gastric ulcer, a splenic, hepatic or pancreatic suppuration, or from spread of infection in general peritonitis.

5. *Right Extraperitoneal.* Suppuration occurs between the diaphragm

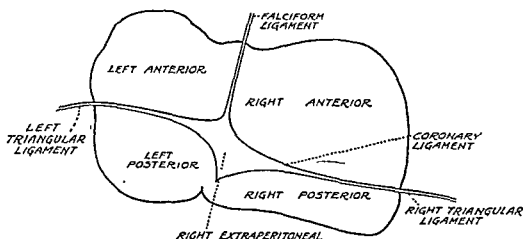


FIG. 12. DIAGRAM: SUPERO-POSTERIOR VIEW OF LIGAMENTS OF LIVER SHOWING SITES OF SUBPHRENIC ABSCESS.

and the bare area of the liver. The infection is due to suppuration in the liver or bile ducts, or a spread from the abdominal wall by the lymphatics in the falciform ligament, or from the right retroperitoneal tissue in a perforated posterior duodenal ulcer, a retrocaecal appendix, ulceration of the ascending colon or hepatic flexure, or a perinephric or pancreatic abscess. It may be secondary to suppuration above the diaphragm.

6. *Left Extraperitoneal.* Suppuration occurs in a potential space formed by stripping the peritoneum off the left side of the diaphragm. The suppuration may be secondary to a left perinephric abscess, a

perforated posterior gastric ulcer, ulceration of the colon, diverticulitis, acute osteomyelitis of the lumbar vertebræ, perforation of the œsophagus, or to suppuration above the diaphragm.

Clinical Findings. Subdiaphragmatic abscess is usually secondary to suppurative appendicitis or to perforation of the stomach or duodenum. There may be a history of an operation from 4 to 7 months previously. The temperature and pulse rate then rise, and the patient becomes more ill. Rigors, sweating and pain in the region of the diaphragm or shoulder may develop.

On Examination: The patient looks ill. If the abscess is anterior a bulging or swelling may be seen under the costal margin, it is dull on percussion, and the chest moves little on the affected side. If the stomach or duodenum have perforated, gas may also be present in the abscess, and a resonant note may be obtained over a small area, which keeps uppermost as the patient is turned from his back to his side. Abnormal signs are found at the base of the corresponding lung, for the diaphragm is raised and may be as high as the second or third rib. Typically four zones can be detected at the back of the chest, at the apex the normal lung, below this is a zone of collapsed lung with some dulness and weak air entry, still lower there is a tympanitic note due to gas in the abscess, and at the base there is liver dulness. When the abscess is a right posterior one, a swelling may be found in the region of the right loin. With a left posterior abscess there may be no swelling seen, or one may be detected in the abdomen above or below the stomach. With an extraperitoneal abscess on the bare area of the liver, the liver is usually displaced downwards, the right diaphragm is raised, and there is dulness and deficient air entry over the lower lobe of the right lung. The blood: There is usually a leucocytosis of 15,000 to 20,000 per c.mm. An X-ray examination may show the position of the diaphragm and of the liver. Exploratory puncture through the 9th, 10th or 11th intercostal space in the line of the vertebral border of the scapula may reveal the abscess, the diaphragm being pierced by the needle before the pus is struck, and so oscillating with respiration.

Differential Diagnosis. A subphrenic abscess is often difficult to diagnose; it may be mistaken for septicæmia or pyæmia, empyema, pneumothorax, perinephric abscess, liver abscess, pyelophlebitis, or a pancreatic cyst. The history, X-ray examination and results of exploratory puncture usually serve to establish the nature of the condition.

Course and Complications. If left untreated, the abscess may cause a secondary pleural effusion or it may rupture into the pleura or lung, with resultant empyema or lung abscess. Rupture may also occur into the pericardium, œsophagus, the general peritoneal cavity, or through the skin. Septicæmia or pyæmia may occur as further complications.

Prognosis. Subphrenic abscess is a serious condition, with a mortality of about 70% if left undrained, which is considerably lowered if adequate treatment is given.

Treatment. The abscess should be drained surgically, but the exploratory puncture should be performed in the theatre by a surgeon prepared

to complete the operation. The sensitivity of the causative organism should be determined and the appropriate antibiotic administered.

Chronic Peritonitis

Definition. Chronic inflammation of the peritoneum.

Etiology. Chronic peritonitis may follow acute peritonitis or occur more insidiously. The following varieties may be recognised :—

Localised Plastic or Proliferative Peritonitis

Etiology. Localised peritonitis may occur after abdominal operations, or secondary to inflammation of the appendix, gall-bladder, uterine tubes, abdominal lymph nodes, diverticula, etc. In other cases it is a form of chronic tuberculous peritonitis. Proliferative peritonitis may be localised around an organ such as the spleen or liver. The latter may be covered with a thick white coat of fibrous tissue ("sugar-iced" liver, see p. 80).

Diffuse Plastic or Proliferative Peritonitis

Etiology. Diffuse peritonitis may occur as a form of chronic tuberculous peritonitis, with carcinoma of the peritoneum or as an extension of a chronic plastic peritonitis of septic origin. In Pick's disease there is a diffuse proliferative peritonitis, often associated with similar proliferative changes in the mediastinum, pericardium and pleura (see p. 224), and with chronic nephritis and arteriosclerosis. In Concato's disease the peritoneum is much thickened, the omentum is often rolled up and there is chronic perihepatitis or perisplenitis. A serous effusion may be present, and when the pericardium and pleuræ are involved the condition is known as polyserositis or polyarrhomenitis. A barium meal may show a peculiar condition of thickening of the stomach, and the cæcum and colon may also be involved.

Chronic Tuberculous Peritonitis

Etiology. The *Mycobacterium tuberculosis* usually gains access to the peritoneum from the intestine, or the mesenteric and retroperitoneal lymph nodes. It may, however, be a blood-borne infection from a focus in any part of the body. Cirrhosis of the liver is a predisposing cause in adults.

Pathology. Certain types are described, which tend to overlap each other. 1. *Tubes mesenterica* : The mesenteric and retroperitoneal lymph nodes are affected. 2. *The plastic or fibroid variety* : Adhesions form, the intestines are matted together, the omentum may be rolled up in a mass, and there is no effusion. 3. *The ascitic form* : The fluid may be free or loculated by adhesions. 4. *The caseous variety* : Softening occurs in the tuberculous foci, there may be localised suppuration and the formation of fecal fistulæ.

Clinical Findings. The patient is usually between the ages of 3 and 25 years. The onset is insidious; thus the child is gradually taken ill

with lassitude, loss of appetite, pallor, abdominal discomfort or colic. The bowels are usually constipated.

On Examination: The child looks somewhat wasted, but the abdomen is often distended. The skin, especially over the abdomen, may be pigmented. In the plastic variety the abdomen has a peculiar doughy feeling. Small masses may be felt, due to lymph nodes or matted omentum. Loculated fluid gives rise to a dull swelling which may simulate an ovarian cyst. When there is free fluid the signs are those of ascites. The temperature is usually slightly raised and irregular, but it may be normal. The bowels are costive in the plastic variety, but with *tabes mesenterica*, obstruction of the lacteals may result in diarrhoea with fatty stools.

Differential Diagnosis. Chronic tuberculous peritonitis may be mistaken for other causes of wasting, *cœliac disease*, chronic appendicitis, regional ileitis, salpingitis, an ovarian cyst, abdominal carcinoma and cirrhosis of the liver, or other causes of ascites. Diagnosis is established in the ascitic variety by removing a specimen of the fluid and injecting it into a guinea-pig, in which tuberculous lesions develop in 2 to 3 months. An X-ray examination which reveals calcified abdominal lymph nodes is in favour of the presence of unhealed tuberculous lymph nodes in the abdomen.

Course and Complications. The course is prolonged in the majority of cases. Complications include intestinal obstruction or perforation, *fæcal fistula* formation, localised suppuration, and general dissemination by the blood stream.

Prognosis. There is usually a tendency to recovery; the most unfavourable developments are the general dissemination of tuberculosis, intestinal obstruction, the formation of *fæcal fistulæ* or of local abscesses.

Treatment. Streptomycin, para-aminosalicylic acid and/or isoniazid should be administered as for acute tuberculous peritonitis. Operation is required for intestinal obstruction.

Cysts of the Peritoneum

The cysts may be mesenteric, hydatid, dermoid, or teratomatous. They cause vague symptoms, such as abdominal discomfort and swelling, and the treatment is surgical.

New Growths of the Peritoneum

These are simple and malignant. Simple growths include a fibroma, lipoma, angioma, lymphangioma, and myoma. Malignant growths may be primary, such as an endothelioma or sarcoma. Usually they are secondary to carcinoma of the ovary, stomach, intestine or breast or to a pleural endothelioma. The peritoneum may be studded with minute nodules and an effusion, serous, hæmorrhagic or chylous, may form.

Ascites

(including *Hydroperitoneum*, *Seroperitoneum*, *Hæmoperitoneum* and *Chyloperitoneum*)

Definition. Non-purulent fluid in the peritoneal cavity.

Etiology. The fluid may be a transudate (*hydroperitoneum*), an exudate (*seroperitoneum*), blood-stained (*hæmoperitoneum*) or fatty (*chyloperitoneum*).

Hydroperitoneum may result from: Heart failure, constrictive pericarditis or obstruction of the inferior vena cava. Cirrhosis of the liver. Obstruction of the portal vein, as by pressure from enlarged lymph nodes in the portal fissure, which may be due to tuberculosis, carcinoma or Hodgkin's disease, or the pressure of an aneurysm or thrombosis. Nephritis, pernicious anæmia or leukæmia. *Seroperitoneum* may be due to: Chronic peritonitis as in tuberculosis, carcinoma or hydatid infection, or to polyserositis, or ovarian tumours. *Hæmoperitoneum* may occur in peritonitis associated with tuberculosis or carcinoma. *Chyloperitoneum* may be due to obstruction of, or injury to the lacteals or to nephritis.

Ascites is thus a sign of diverse pathological states.

Pathology. The fluid: In *hydroperitoneum* the transudate is clear, straw-coloured, with a specific gravity usually below 1·015, containing protein under 2% and a few cells. In *seroperitoneum* the fluid may be darker, the specific gravity is usually over 1·015, the protein content is higher (over 3%) and the cells are more numerous. In *hæmoperitoneum* red blood corpuscles are present. *Chyloperitoneum* may be chylous fluid, whitish-yellow and turbid, with chyle; a pseudochylous fluid may form in which the fat comes from degenerating cells. Portal hypertension is the most important factor in the production of ascites in liver disease, hypoproteinæmia is of great importance in ascites associated with generalised œdema.

Clinical Findings. The clinical picture varies according to whether the cause is cardiac, hepatic, renal, etc. The local symptoms and signs are as follows: The patient complains of abdominal swelling, heaviness or discomfort. There may also be dyspnœa or palpitations with swelling of the legs.

On Examination: The abdomen appears fairly uniformly distended when the patient is lying, with some prominence in the flanks, provided the fluid is not loculated. If there is a large quantity of fluid the umbilicus may be everted and *striae atrophicæ* may be seen. Enlarged veins may be present around the umbilicus (*caput Medusæ*) and with portal thrombosis dilated veins appear in the hypogastrium, in which the direction of flow is reversed (i.e., the blood passing from below upwards). On palpation a fluid thrill may be obtained. The thrill is transmitted to one hand placed on the abdomen in the flank, when the other flank is flicked with the finger; the ulnar margin of an assistant's hand should be used to compress the abdominal wall in the centre, to prevent transmission of the thrill along the wall. On percussion there is dulness in the flanks and hypogastrium, and this

shifts when the patient turns on his side, the upper portion becoming resonant. If the liver is enlarged it may be felt by suddenly pressing with the fingers over it ("dipping"). With small degrees of ascites the dulness may become apparent in the umbilical region by percussing the abdomen with the patient in the knee-elbow position. Loculated ascites may cause dulness in one zone of the abdomen, which does not shift with change of position. There may be œdema of the legs and scrotum, and the urine may contain a trace of protein.

Differential Diagnosis. Ascites must be distinguished from abdominal distention due to a full bladder, an ovarian cyst, a tumour or flatulent intestinal distention. The bladder should be emptied. With an ovarian cyst the swelling is mainly below the navel, the dulness does not extend to the flank or shift as it does with free fluid in the peritoneum, and on vaginal examination displacement of the uterus may be felt. With a tumour, the mass, if palpable, is generally firm and there is no shifting dulness. With flatulent distention the abdomen is hyperresonant, but flatulent distention and ascites often coexist.

Course and Complications. These must vary with the underlying cause of the ascites.

Prognosis. Ascites is almost always a serious condition, in many instances being the harbinger of death. The outlook is more favourable in cases due to congestive heart failure and a few cases of *benign ascites* have been described, which have not recurred after paracentesis, and for which no cause was discovered.

Treatment. The treatment for ascites due to cirrhosis has been described on p. 88.

THE MESENTERY

The following affections of the mesentery will be briefly described : Inflammation (mesenteritis), structural abnormalities, hæmorrhage, thrombosis, embolus, cysts, new growths, and tuberculous lymph nodes.

Inflammation (*Mesenteritis*)

This may form part of a general peritonitis or be localised to a part of the mesentery as the result of spread of infection from adjacent intestine.

Structural Abnormalities

Excessive length of the mesentery may lead to volvulus, and the bowel may become incarcerated through an opening in the mesentery.

Hæmorrhage

This may occur rarely in the hæmorrhagic varieties of the acute specific fevers, such as small-pox, or as the result of degenerative changes such as arteriosclerosis or aneurysm of the mesenteric arteries. It produces symptoms resembling those of intestinal obstruction.

Thrombosis and Embolus

Venous thrombosis may result from cirrhosis of the liver and congestive heart failure, or develop in association with pylephlebitis or intestinal or appendicular suppuration, or after splenectomy. It may also occur as a manifestation of thrombo-phlebitis migrans and visceral angina. An embolus may lodge in the mesenteric arteries in cases of bacterial endocarditis and mitral stenosis. The clinical picture is that of an acute abdominal emergency. The patient is suddenly taken ill with severe abdominal pain, collapse, sweating, pallor, low temperature, and frequent pulse. The abdominal wall is not usually rigid. Some blood and mucus are passed by the intestine ; in a few hours the abdomen becomes distended, and vomiting and perhaps hæmatemesis set in. Gangrene or perforation of the intestine may occur. The outlook is very grave, and the treatment is surgical.

Cysts and New Growths

Mesenteric cysts may be hæmorrhagic, serous, lymphatic, or due to hydatid infection or to a dermoid. They form rounded swellings in the abdomen and cause vomiting, colic or intestinal obstruction.

New growths are usually secondary malignant deposits.

Tuberculous Lymph Nodes

(*Tabes Mesenterica*)

Tabes mesenterica is described on p. 119 (chronic tuberculous peritonitis).

CHAPTER II

THE RESPIRATORY SYSTEM

RESPIRATORY FUNCTION TESTS

Ventilatory Function. Vital capacity. This is the amount of air which can be expelled after a deep inspiration. It normally varies between 3,000 and 5,000 ml.

Inspiratory Reserve Volume (I.R.V.) or Complemental Air. The volume of air which can be breathed in after a normal inspiration. It is 1,500 to 3,000 ml.

Expiratory Reserve Volume (E.R.V.). The volume of air which can be breathed out after a normal expiration. It is 1,200 to 1,500 ml.

Tidal volume (T.V.). The volume of air inspired and expired during quiet breathing. It is 350 to 500 ml.

Residual Volume (R.V.). The amount of air in the lungs at the end of maximal expiration. It is 1,200 to 1,500 ml.

Functional Residual Capacity (F.R.C.). The volume of air in the lungs at the end of a normal expiration. It is 2,000 to 3,000 ml.

Dead Air Space. The amount of tidal air from the nostrils to the terminal bronchioles where no gaseous exchange takes place. It is 150 to 170 ml.

Total Lung Capacity. The amount of air in the lungs after a maximal inspiration. This is 5,500 to 6,000 ml.

Lung Compliance. This measures the elastic resistance of the lung to inflation, as indicated by volume change in ml. per cm. H_2O rise in pressure. Normally it is 120 ml. per cm. H_2O rise in pressure.

Forced Expiratory Volume (F.E.V.₁). The volume of air expired with forced expiration in one second. This is 80% of the vital capacity in one second, the remainder in 2 to 3 seconds.

Forced Expiratory Time (F.E.T.). The patient takes a deep breath and then expires as quickly as he can. The doctor listens over the trachea with a stethoscope and measures the time of the expiration. If the F.E.T. is over 6 seconds there is probably air-way obstruction.

Peak Flow Rate (P.F.R.). A single maximum puff is measured in a Wright portable meter, calibrated from 50 to 1,000 litres per minute. The de Bono whistle gives a satisfactory response up to 300 litres per minute. The average rate for adult males is 500 to 600 litres, and 200 litres lower for women.

Bronchspirometry. By means of a catheter passed down the trachea the ventilating function of each lung can be determined.

Gaseous Exchange in Alveoli. The diffusion rate of oxygen and carbon dioxide from air to blood and vice versa is rapid, that for CO_2 being twenty times quicker than for O_2 . The plasma CO_2 tension (pCO_2) is measured by the rebreathing method. Arterial blood is required for determination of pO_2 .

The variations in the respiratory function tests in certain diseases are mentioned under the disease headings.

THE UPPER RESPIRATORY TRACT

Hay Fever (*Allergic Coryza. Pollinosis*)

Definition. Paroxysmal and seasonal inflammation of the conjunctivæ and nasal mucous membrane.

Etiology. Hay fever is due to sensitiveness to certain pollens. In England the pollen is usually that of the "Timothy grass," and more rarely tree pollens. In the autumn the Michaelmas daisy is an occasional cause.

Pathology. The condition is one of allergy, the patient exhibiting an abnormal sensitivity to foreign proteins or to altered tissue proteins. There is hyperæmia of the conjunctivæ, of the nasal mucous membrane, and sometimes of the larynx and trachea.

Clinical Findings. The patient is usually a young adult, who gives a history that every year in the early summer from May to July he suffers from attacks of sneezing, watering of the eyes and often headache. There may be much watery discharge from the nose and some malaise. He may also suffer from asthma at different periods of the year. The attacks are more common in the country, especially if near a hay field. They also occur in towns.

Differential Diagnosis. The diagnosis is established by the seasonal incidence and the cutaneous reaction of the patient to pollen. Hay fever should be differentiated from paroxysmal sneezing due to local irritation of the nose, or to nervous influences (*nervous coryza*). In paroxysmal rhinorrhœa, attacks of sneezing or of running from the nose occur at all times of the year. This is probably a vasomotor phenomenon due to allergy, the patient being sensitive to dust, snuff, orris-powder, feathers, animal emanations, bacteria, etc.

Course and Complications. The course of the disease is limited by the life history of the plants producing the pollen. Asthma or a perennial coryza may develop as complications.

Prognosis. This is good, as subsequent attacks may be prevented or modified by appropriate treatment. Hay fever tends to lessen in severity in successive years, and to disappear in about 20 years.

Treatment. Prophylactic. Early in the year the cutaneous reaction to Pollaccine should be determined. A control prick is first made through a drop of normal saline with a hypodermic needle. A drop of Pollaccine containing 20,000 units of pollen toxin per ml. is placed on the forearm and a prick is made through it. The drops are then wiped off with cotton-wool. A positive reaction is shown in about 15 minutes by the formation of an urticarial wheal surrounded by a red areola. Desensitisation should be begun early in February, it is dangerous to give it in the hay fever season. Subcutaneous injections of Pollaccine are given every other day. The initial dose varies from 40 to 100 units, and a 15% increase is made at each injection. In order to obtain adequate protection a final dose of 50,000 to 100,000 units will be required. A local reaction may be prevented by taking calcium lactate

10 gr. (0.6 G.) half an hour before the injection. A marked local or general reaction can be checked by the subcutaneous injection of 3 to 5 m. (0.2 to 0.3 ml.) of inject. adrenaline (B.P.) 1 in 1,000. Should a reaction occur the next injection should be the largest preceding dose that did not cause a reaction. "D-Vac Pollens" is a depot pollen vaccine of which three subcutaneous injections are given at 4-weeks interval, starting early in February. The details supplied by the makers (Bencard Allergy Unit) should be strictly observed.

Allpyral, alum-precipitated pyridine extract of grass pollen, is also available for prevention and treatment of hay fever. It is put up in 3 x 5 ml. vials, containing 100, 1,000 and 10,000 P.N.U. (protein nitrogen units) per ml. The *pre-seasonal* injections for a moderately sensitive case are 20, 50, 100, 200, 400, 800, 1,500, 2,000 and 4,000 P.N.U. at weekly intervals. The *co-seasonal* dosage for such a case is 5, 10, 20, 40, 70, 100 and 200 P.N.U. once a week. The makers' (Dome) instructions should be carefully observed.

Curative. Considerable relief can often be obtained by the daily subcutaneous injection of 100 units pollen toxin and a subcutaneous injection of 3 m. (0.2 ml.) of inject. adrenaline (B.P.) 1 in 1,000. Further treatment for the patient who is suffering from hay fever consists in wearing dark glasses. The nasal mucous membrane may be protected by white Vaseline, or by Anesthone cream. Phenylephrine (Fenox) or naphazoline (Privine) drops up the nostrils may give temporary relief. Hydrocortisone snuff gives good immediate results. Antihistamine drugs such as mepyramine malleate (Anthisan) 50 mg. tab., or Dibistin 50 mg. tab., the latter being a combination of Antistin and Pyribenzamine, may be helpful if taken 3 or 4 times a day.

Epistaxis

Definition. Bleeding from the nose.

Etiology Epistaxis may be due to local or general causes. *Local causes:* Trauma, picking the nose, foreign bodies in the nose, nasal diphtheria, new growths such as a polypus or malignant tumour, lupus, syphilis, telangiectases (which may be hereditary), a fractured base or a pituitary tumour. *General causes:* Epistaxis may be associated with high blood pressure, mitral stenosis, portal cirrhosis of the liver, typhoid fever, whooping-cough, blood diseases such as leukæmia, anæmia, hæmophilia and purpura, and a lowered atmospheric pressure such as occurs at high altitudes. It may also occur at puberty without any discoverable cause.

Pathology. The bleeding point is often situated at the anterior and inferior part of the septum nasi.

Differential Diagnosis. Blood which passes backwards from the nose may be coughed up and raise the question of hæmoptysis. A careful naso-pharyngeal examination will usually reveal the bleeding point. In other cases the blood may be swallowed and vomited or cause melæna.

Course and Complications. Usually the bleeding stops in a short time, but it may be persistent and cause anæmia and debility.

Prognosis. This depends on the cause. Epistaxis may be trivial, or it may be a symptom of a fatal disease.

Treatment. This varies with the cause. In children the bleeding usually stops without treatment, unless due to a foreign body, which should be removed. In other cases a cold compress should be applied to the nose with the patient lying down, or a little cotton-wool inserted into the nostril and pressure applied over it. The wool may be soaked in liq. adrenal. hydrochlor. or in viper venom as described on p. 559. In persistent cases the bleeding point should be sealed by the galvano-cautery at cherry-red heat. Epistaxis associated with a high blood pressure is a useful safety valve and does not require to be checked, unless very excessive.

THE LARYNX

Acute Simple Laryngitis

Definition. Acute catarrhal inflammation of the larynx.

Etiology. Acute simple laryngitis may be a symptom of a common cold, or result from inhalation of irritants. It may also occur as an early manifestation of measles, or be due to improper production or over-use of the voice.

Pathology. There is hyperæmia of the vocal folds (cords) and epiglottis, with exudation of mucus.

Clinical Findings. The patient complains of alteration in his voice, varying from harshness to hoarseness or aphonia. The throat may feel raw and there may be malaise with an irritating cough.

On Examination : The temperature may be a little above normal, and laryngoscopic examination will reveal the redness or swelling of the larynx.

Differential Diagnosis. Acute simple laryngitis must be differentiated from functional aphonia and from such serious conditions as laryngeal diphtheria, tuberculosis, syphilis or carcinoma of the larynx, which are described later.

Course and Complications. The laryngitis usually improves in 7 to 10 days, but the course is more prolonged if the voice has been strained or if irritants have been inhaled.

Treatment. The voice should be rested. If there is any fever the patient should be kept in bed, the temperature of the room maintained at 65° F. (18·3° C.), and the air moistened by a steam kettle. A steam inhalation should be used for 5 minutes 3 times a day, such as Ol. pini 10 m. (0·6 ml.), mag. carb. lev. 10 gr. (0·6 G.), aquam ad 120 m. (8 ml.), 120 m. (8 ml.) in 1 pint (600 ml.) of steaming water at 165° F. (73·8° C.). Cough can be checked by a sedative mixture such as Tnc. opii camph. 20 m. (1·2 ml.), tnc. ipecac. 5 m. (0·3 ml.), syr. pruni serotin. 80 m. (2 ml.), aq. chlorof. ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) t.d.s.

Chronic Simple Laryngitis

Definition. Chronic catarrhal inflammation of the larynx.

Etiology. Chronic simple laryngitis may result from irritants, such as tobacco and various forms of dust, from over-use or faulty use of the voice, or from prolonged coughing associated with chronic bronchitis or pulmonary tuberculosis. It may also be secondary to chronic infection in the mouth, nose or pharynx.

Clinical Findings. The onset is usually insidious, the patient complaining of hoarseness or of weakness of the voice. The throat may feel dry and there may be an irritating cough.

On Examination: The pharynx is usually red, and swelling or redness of the vocal cords may be seen.

Treatment. The patient should rest the voice as much as possible, and give up smoking and alcohol. A steam inhalation should be used at night, as described above, and during the day a potassium chlorate lozenge may be sucked occasionally. Subsequently lessons should be taken in voice production, if the laryngitis has been caused by errors in this respect, and a dusty occupation should be changed, if possible. In obstinate cases a change of air and rest may effect a cure.

Tuberculous Laryngitis

Etiology. Tuberculous laryngitis is usually associated with pulmonary tuberculosis, and is due to infection with the *Mycobacterium tuberculosis*.

Pathology. The disease may be localised to the vocal folds (cords), inter-arytenoid space, ventricular folds or epiglottis. There may be swelling, infiltration or ulceration. The posterior part of the vocal cords is most often affected.

Clinical Findings. Tuberculous laryngitis is very rarely seen now, thanks to the special antibacterial drugs. The patient's first complaint may be of hoarseness or of loss of voice. In other cases he may develop these symptoms as a complication of a recognised pulmonary tuberculosis. If the epiglottis is involved the patient may notice difficulty in swallowing liquid foods, any attempt to do so provoking cough. In the later stages there may be severe pain on swallowing, felt in the throat and radiating to the ear.

On Examination: Various lesions may be found in the larynx, such as swelling or ulceration of the inter-arytenoid space or of a vocal cord. The vocal cord may be fixed by the granulation tissue.

Differential Diagnosis. Tuberculous laryngitis has to be differentiated from a simple laryngitis which may occur in pulmonary tuberculosis, and from syphilis or a new growth. The opinion of an expert laryngologist will be required. In addition the sputum must be tested for tubercle bacilli, the lungs X-rayed, the Wassermann reaction determined, and a portion of the diseased tissue may require microscopical examination after removal by punch forceps.

Course and Complications. Tuberculous laryngitis may be cured by suitable treatment, especially in the early stages. Pulmonary tuberculosis is usually present.

Treatment. This is described on p. 169.

Syphilis of the Larynx

Etiology. Laryngeal syphilis is due to infection with the *Treponema pallidum*.

Pathology. *Congenital syphilis:* A catarrhal syphilitic laryngitis may occur in infancy, or a gumma may develop about the age of puberty.

Acquired syphilis : Lesions may occur during the secondary stage, such as patchy hyperæmia of the cords, with formation of mucous spots. In tertiary syphilis, the lesions include infiltration, serpiginous ulceration, gumma formation or stenosis of the larynx. The anterior part of the larynx is more commonly affected than the posterior.

Clinical Findings. There is usually no pain and no cough, but the voice is hoarse or raucous. Stridor is indicative of stenosis, due to contraction of fibrous tissue.

Differential Diagnosis. This is as for tuberculous laryngitis. The diagnosis is established by the laryngoscopic appearances, the Wassermann reaction and the response to treatment.

Treatment. A full course of anti-syphilitic treatment is required (see p. 600). Caution must be exercised in the administration of iodides, as œdema of the larynx may ensue.

Tumours of the Larynx

These may be simple or malignant.

Simple Tumours

These include : Papilloma, fibroma, " singer's nodule " (keratoderma), angioma and degeneration cysts.

Pathology. Innocent tumours often grow from the vocal cords, at the junction of the anterior and middle thirds of the cord. A papilloma is frequently pedunculated.

Clinical Findings. The patient may have no symptoms, but if the tumour is growing from a vocal cord there is usually hoarseness, and there may be some stridor. An angioma may give rise to hæmoptysis.

Differential Diagnosis. This is made by laryngoscopic examination and the microscopical appearances of the tumour, after removal.

Treatment. This is surgical.

Malignant Tumours

Pathology. Intrinsic growths occur in the larynx. The commonest variety is the epithelioma. This may be a sessile tumour on a vocal cord, or an infiltration of the tissues of the cord. It may occur in other sites, such as the ventricular fold or the posterior commissure. Extrinsic growths may be found in the epiglottis or around the cricoid cartilage. Cordal carcinoma is very rare in women, and when extrinsic laryngeal carcinoma appears in women it is nearly always situated centrally. Secondary deposits in the cervical lymph nodes occur comparatively late in cases of intrinsic laryngeal carcinoma, but early in extrinsic growths. Spheroidal-celled carcinoma and sarcoma are both rarely seen.

Clinical Findings. The patient is usually a male over the age of 40. He first complains of hoarseness or of weakness of the voice, often thought to be due to a cold, but which persists despite treatment. Later, there is pain, especially on swallowing, and progressive deterioration of health, due to cachexia from the growth.

On Examination : The growth is seen on laryngoscopic examination. Later, secondary deposits occur in the cervical lymph nodes, and second-

ary infection of the growth may give rise to cervical cellulitis or abscess formation.

Differential Diagnosis. This can only be carried out by an expert laryngologist.

Treatment. This is surgical, or by X-rays or radium.

Œdema of the Larynx

Definition. Swelling of the larynx, due to exudation of fluid.

Etiology. Œdema of the larynx may be inflammatory or non-inflammatory. *Inflammatory œdema.* This may occur in association with acute catarrhal laryngitis, septic pharyngitis, cellulitis of the neck (Ludwig's angina), erysipelas of the face and neck, ulceration of the larynx due to syphilis or tuberculosis, or rarely as a complication of diphtheria, scarlet fever, typhoid fever, etc.

Non-inflammatory œdema. This may be a manifestation of angio-neurotic œdema, or be associated with cardiac or renal disease, or it may result from hypersensitiveness to drugs, such as iodides.

Pathology. The swelling affects chiefly the aryteno-epiglottidean folds, the vocal cords being only slightly involved owing to the tense attachment of their mucous membrane. The epiglottis and subglottic region of the larynx may be very swollen.

Clinical Findings. The patient is often a child, who is suddenly seized with dyspnoea and symptoms of asphyxiation. There is a hoarse cry and inspiratory stridor. The swollen epiglottis can usually be seen on oral examination.

Treatment. If the swelling is due to angio-neurotic œdema, a subcutaneous injection of 0.5 to 1 ml. of inject. adrenaline (B.P.) 1 in 1,000 should be given immediately, and a spray may be used in an atomiser containing neb. isoprenal. (B.P.C.). If the œdema is due to other causes, the immediate treatment consists in giving ice to suck, the application of ice-cold compresses to the neck, and scarification of the œdematous epiglottis with a curved guarded bistoury, after cocainisation. In very severe cases tracheostomy may be necessary. In cases due to iodide idiosyncrasy relief may usually be obtained by giving sod. bicarb. 60 gr. (4 G.) t.d.s., and by omitting the iodides.

Croup

Definition. A crowing form of respiration met with in infants and young children.

Etiology. The following varieties may be distinguished :—

1. *Inflammatory* : Laryngitis stridulosa. Membranous laryngitis (diphtheritic and non-diphtheritic). Simple acute laryngitis. Whooping-cough.

2. *Reflex* : Laryngismus stridulus. Croup associated with enlarged tonsils and adenoids, with dentition, tetany and rickets.

3. *Mechanical* : Infantile laryngeal stridor. Laryngeal polypi. Foreign bodies in the larynx. Pressure of an enlarged thymus upon the trachea.

Certain of these varieties will be briefly described.

Laryngitis Stridulosa

Clinical Findings. This is an affection of young children. The symptoms of a cold are usually present, with a cough and perhaps some hoarseness during the day. The breathing is easy when the child goes to bed, but he wakes up during the night with an attack of "croup," characterised by cough, inspiratory stridor and cyanosis. This usually passes off in from a few minutes to half an hour, when the child falls to sleep again.

Prognosis. The condition may be alarming, but is not fatal.

Treatment. If the attack does not rapidly subside the child should be put in a hot bath. A steam inhalation from hot, but not boiling, water should also be given (see p. 127) or the nose and pharynx sprayed with neb. isoprenal. (B.P.C.). If these measures do not afford relief, an emetic dose of tnc. ipecac. should be given, such as 120 m. (8 ml.) for a child of 6 years. Subsequently if the tonsils and adenoids are enlarged, they should be removed.

Laryngismus Stridulus

(*Spasmophilia. Breath-holding Attacks*)

Etiology. This variety of croup may be a manifestation of tetany. It is considered by some to be analogous to asthma, and is often associated with rickets, enlarged tonsils or dentition.

Pathology. There is laryngeal spasm, but no inflammation.

Clinical Findings. The patient is usually an infant, who is suddenly seized during the night with an attack of laryngeal spasm. After some struggling the vocal cords relax and the air enters with a crowing sound. Carpo-pedal spasm may be present during the attack.

Prognosis. Death may occur during the attack.

Treatment. *During the attack:* The tongue should be pulled forward by passing the finger behind it and cold water sprinkled over the head and chest. If this fails, a little chloroform placed over the mouth on lint may cause the child to inhale. *After the attack:* The blood calcium should be estimated, and if low, calcium lactate given by mouth in doses of 1 gr. (60 mg.) t.d.s. to a child of 1 year. Rickets should be treated if present, and enlarged tonsils and adenoids should be removed.

Infantile Laryngeal Stridor

This is due to a congenital deformity of the larynx, in which the orifice is unduly small. It disappears as the child grows.

Laryngeal Paralysis

Introductory. The vocal cords are adducted on phonation, and abducted with inspiration. These movements are effected by intrinsic muscles. The adductor group includes the lateral cricoarytenoid muscles, the transverse arytenoid and the lateral part of the thyroarytenoid muscles. The abductors are the posterior cricoarytenoid muscles. The cricothyroid muscles also help to render the cords taut.

Adduction is a specialised movement, controlled by a cortical centre.

Abduction is mechanical, and regulated by a centre in the medulla. In functional paralysis adduction is affected, whereas in organic disease abduction is first lost. *Semon's law* states that in a progressive organic lesion the intrinsic laryngeal muscles are affected in the following order: Abductors, tensors and adductors.

The nervous path consists of a centre in the third frontal gyrus of the brain, and this is bilateral. Thence upper motor neurones pass in the internal capsule to the lower motor neurone centre in the medulla (X and XI cranial nerve nuclei). The lower motor neurones run in the vagus, the superior laryngeal branch of which supplies the cricothyroid muscle, and the recurrent laryngeal branch innervates the other intrinsic muscles (the lateral and posterior cricoarytenoids, the transverse arytenoid and the thyroarytenoids).

Functional Aphonia

Etiology. Functional aphonia occurs in association with hysteria, shell-shock, debility, or at times with pulmonary tuberculosis.

Clinical Findings. The patient speaks in a whisper, but can cough normally. There is no dyspnoea.

Laryngoscopic Examination: The cords appear normal at rest, but on phonation adduction is incomplete. Abduction is normal with inspiration.

Treatment. The general condition of the patient should be improved with a tonic such as syrup glycerophosph. co. (B.P.C.) 60 m. (4 ml.) t.d.s. The voice may sometimes be immediately restored by local intralaryngeal faradic stimulation, or by firm depression of the tongue with the middle finger of the right hand, while the patient is told to cough and finish the cough on the sound "Ah." Suggestion is of great value in some cases. The aphonia, however, often recurs.

Organic Laryngeal Paralysis

Etiology. The lesion may be in the brain, medulla oblongata, vagus, superior laryngeal or recurrent laryngeal nerve, or there may be a local laryngeal lesion, such as ankylosis of the arytenoid cartilage. *A cerebral lesion:* This must be bilateral to paralyse the vocal cords, for stimulation of one centre causes adduction of both cords. It is therefore very rare. *A nuclear lesion:* Involvement of the nuclei of the X and XI cranial nerves results in homolateral cord paralysis. The chief causes are tabes dorsalis, a gumma, a hæmorrhage, a new growth, multiple sclerosis, syringomyelia, amyotrophic lateral sclerosis, poliomyelitis, and labio-glosso-pharyngeal paralysis. These lesions are often bilateral. *The vagus:* This may be involved in a fracture or tumour of the base of the skull or by pachymeningitis or neuritis. *The superior laryngeal nerve:* This is rarely affected, but it may be compressed by enlarged cervical lymph nodes, or damaged by trauma or by diphtheritic neuritis. Such a lesion causes loss of tension in the vocal cords. *The recurrent laryngeal nerve:* This may be compressed by an aneurysm, lymph nodes in the neck, a thyroid tumour, carcinoma of the œsophagus, chronic apical pleurisy especially on the right side, a dilated left atrium in mitral

stenosis, bronchial carcinoma, a mediastinal tumour, cervical or mediastinal abscess, and a pericardial or pleural effusion. It may also be affected by neuritis due to such causes as cold, diphtheria, alcohol, arsenic or lead. It may be injured at an operation. The following varieties of organic paralysis may be due to any of the causes given above.

Unilateral Abductor Paralysis

Clinical Findings. There is no cough, the voice is normal or hoarse, and there may be some dyspnoea on exertion.

Laryngoscopic Examination: The cord lies near the mid-line at rest, it does not abduct on inspiration, but on phonation the cords meet.

Total Paralysis of One Cord

Clinical Findings. The voice may be low and hoarse, but there is no cough and usually no dyspnoea.

Laryngoscopic Examination: The cord is in the "cadaveric" position, mid-way between adduction and abduction. It does not move on phonation or on inspiration. On phonation the sound cord comes across the mid-line to meet the paralysed one.

Bilateral Abductor Paralysis

Clinical Findings. The voice is practically normal, but there is inspiratory stridor.

Laryngoscopic Examination: Both cords at rest lie near the mid-line. They adduct on phonation, but there is no abduction on inspiration. Tracheostomy may be required to relieve the dyspnoea.

Bilateral Complete Paralysis

Clinical Findings. The patient can only whisper, but stridor is not present.

Laryngoscopic Examination: Both cords are in the "cadaveric" position, and they are immobile on phonation and on inspiration.

THE TRACHEA

Tracheitis

Etiology. Tracheitis may be acute or chronic. *Acute tracheitis.* This is usually bacterial in origin, occurring either with a cold, which extends to the large bronchi, or in association with whooping-cough or influenza. It may also be met with in measles, diphtheria or typhoid fever. Inhalation of irritants, such as poison gases or steam, is a causative factor in some cases. *Chronic tracheitis.* This may follow acute tracheitis, or be due to chronic irritation from smoking. It may be secondary to chronic inflammation of the nose or larynx, or to a local lesion in the trachea, such as a tumour or gumma.

Pathology. The inflammatory changes vary in degree from the vascular engorgement exemplified by the "pink" trachea of influenza,

to membrane formation with sloughing as may occur in diphtheria or gas poisoning.

Clinical Findings. In acute tracheitis the patient complains of a sense of soreness under the sternum, but the symptoms of the associated laryngitis and bronchitis are usually more noticeable.

Treatment. In the acute stages the patient should be kept in a warm room, and if there is fever he should be in bed. Counter-irritants should be applied over the upper part of the sternum and lower part of the neck, such as lin. camphoræ (B.P.). A sedative cough mixture should be given, such as Tnc. opii camph. 30 m. (2 ml.), liq. ammon. acetat. 60 m. (4 ml.), syrup. pruni serotin. 30 m. (2 ml.), aq. chlorof. ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) t.d.s. A steam inhalation containing tnc. benzoin. co. 60 m. (4 ml.) in a pint (600 ml.) of steaming water, at a temperature of 165° F. (73.8° C.), should be used 2 or 3 times a day.

Tracheal Obstruction

Etiology. The obstruction may be due to causes in the lumen of the trachea, in the wall or outside the wall.

1. *In the lumen* : This may result from an inhaled foreign body, or from a pedunculated tumour, such as a papilloma.

2. *In the wall* : Obstruction may be caused by cicatrization of a wound or tracheostomy scar, or by fibrosis following the inhalation of severe irritants. Syphilis, leprosy, scleroma and secondary malignant deposits are rare causes of obstruction.

3. *Outside the wall* : Obstruction may result from pressure due to an enlarged thyroid ("scabbard" trachea), enlarged cervical lymph nodes, especially if affected by malignant growths or Hodgkin's disease, an aneurysm, an enlarged thymus or a mediastinal tumour.

Clinical Findings. These vary with the degree of obstruction and the suddenness of its onset. The most noticeable symptoms are dyspnoea and tracheal stridor. Pressure from an enlarged thymus in infants, resulting in tracheal stridor, is very liable to be mistaken for croup due to laryngeal obstruction. The dyspnoea is often relieved by leaning the infant forward. The temperature is normal, and the cyanosis and dyspnoea may improve markedly from time to time. A foreign body which has passed through the larynx often gives rise to very slight symptoms when it is in the trachea, and it usually rapidly passes into a bronchus. In slowly developing obstruction the stridor is often heard first when the patient is asleep. When the obstruction is severe, respiratory excursions of the larynx are obvious, and the accessory respiratory muscles are in action.

Treatment. This varies with the cause of the obstruction. Tracheostomy must not be performed in cases of thymic stridor, as it will only precipitate death. The possibility of X-ray treatment should be considered, and the baby must not be allowed to lie down. Foreign bodies in some cases can be located by X-ray examination and removed with a bronchoscope. In organic stenosis in the cervical portion of the trachea, it may be possible to relieve the dyspnoea by a low tracheostomy. Usually nothing can be done to relieve obstruction in the mediastinum

due to external pressure, unless there is a tumour which can be removed by operation.

Tracheal Diverticula

Tracheal widening, with protrusion of its mucous membrane between the rings, is a rare condition, revealed at times by endoscopy or by Lipiodol examination.

THE BRONCHI

Acute Bronchitis

The following varieties are described: Tracheobronchitis, suppurative and fibrinous bronchitis.

Acute Tracheobronchitis

Definition. Acute inflammation of the larger bronchial tubes, usually associated with tracheitis.

Etiology. *Primary cases:* The exciting organisms are most often the *Streptococcus pneumoniae* (pneumococcus) and the *Haemophilus influenzae*. Less often the organisms found are staphylococci, streptococci, *Klebsiella pneumoniae* (Friedländer's bacillus) and virus infections, moniliasis and trichiniasis. Inhalation of dust and chemical irritants may also cause acute bronchitis. *Predisposing causes:* 1. Age: Childhood and late adult life. 2. Sex: Males predominate. 3. Climate: Damp and wet. 4. Season: Autumn and winter. 5. Heredity: There is often a hereditary factor.

Secondary cases: Acute catarrhal bronchitis may occur as a complication in such diseases as measles, whooping-cough, influenza, typhoid fever, diphtheria, nephritis, pulmonary tuberculosis, malaria, etc.

Pathology. The lower part of the trachea and the main bronchi are affected. The mucous membrane is hyperæmic in the early stages, with little secretion; later a thin mucous exudate appears which becomes muco-purulent, and finally ceases.

Clinical Findings. The patient is taken ill with a cold, which passes down to the chest. There is malaise, with perhaps headache and shivering as the temperature rises. A sense of rawness may be felt under the sternum, or in the second and third intercostal spaces near the sternum. A dry cough causes pain in the chest, which disappears as the secretion forms and is expectorated.

On Examination: The temperature may be raised to 100° or 101° F., (37·8° or 38·3° C.), the respiration may be slightly increased to 18 or 20, and the pulse is also somewhat frequent, 90 to 100. The chest. **Inspection:** Movement is good and equal. **Palpation:** Rhonchal fremitus may be present on both sides; tactile fremitus is normal. **Percussion:** The note is normal. **Auscultation:** The breath sounds are harsh or they may be almost obscured by sonorous or sibilant rhonchi. As the secretion loosens, bubbling râles may be heard. Vocal resonance is normal. The sputum is scanty and tenacious at first; later it increases and is more purulent.

Differential Diagnosis. There is usually no difficulty in the diagnosis,

either of the primary or secondary cases. The sputum should be examined and the lungs X-rayed to exclude the possibility of tuberculosis.

Course and Complications. The disease usually pursues a course lasting 2 to 3 weeks, the temperature falling to normal in a week or so. Chronic bronchitis may ensue as a sequela.

Prognosis. This is good, unless the patient is very young or very old, when the disease may prove fatal.

Treatment. The patient should be kept in bed in a warm and moist atmosphere, the temperature being maintained between 60° and 65° F. (15.5° and 18.3° C.) day and night, and a steam kettle used. In severe cases antibiotics should be given without awaiting the result of sputum culture. Benzylpenicillin, 1 million units (600 mg.), should be injected intramuscularly every 12 hours. Alternatively tetracycline (Achromycin) can be given by mouth, beginning with 1 G. (4 capsules), and followed for 2 days by 0.5 G. six-hourly, and then 0.25 G. six-hourly for about 5 days. During the dry stage a steam inhalation may be used, such as *Ol. pini* 10 m. (0.6 ml.), *mag. carb. lev.* 10 gr. (0.6 G.), *aq. ad* 120 m. (8 ml.). 120 m. (8 ml.) in a pint (600 ml.) of steaming water at 165° F. (73.8° C.). The vapour to be inhaled from a Nelson's inhaler for five minutes night and morning. For an irritating dry cough syrup *codein. phosphat. (B.P.C.)* may be given in doses of 30 to 60 m. (2 to 4 ml.) *t.i.d.* Bronchial spasm may be relieved by the methods recommended for an attack of asthma. Sleep may be induced by the use of some preparation such as *Seconal*, 1½ gr. (0.1 G.) capsule, one or two, or in some adult cases *pulv. ipecac. et opii* 10 gr. (0.6 G.). The bowels should be opened daily with a saline, such as *mag. sulph.* 60 to 120 gr. (4 to 8 G.) *mane*. During the febrile stage the diet should be liquid or semi-solid. As the secretion loosens and the cough becomes easier, a stimulant expectorant should be given, such as *Ammon. carb.* 3 gr. (0.2 G.), *tnc. scillæ* 5 m. (0.3 ml.), *sp. chlorof.* 7 m. (0.45 ml.), *infus. senegæ rec.* *ad* 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) *t.d.s.* If there are signs of dilatation of the right side of the heart cardiac and respiratory stimulants should be given, such as *digoxin* 0.5 mg. in 1 ml. 70% alcohol diluted with 9 ml. normal saline, injected intravenously, slowly, or *nikethamide* (*Coramine*) 2 ml. six-hourly subcutaneously. In a severe case 10 ml. of *nikethamide* may be injected intravenously. If possible, a period of convalescence should be arranged in a warmer climate.

Capillary Bronchitis

This variety of acute bronchiolitis is often indistinguishable from bronchopneumonia. It may be associated with influenza, measles or scarlet fever. *Bronchiolitis fibrosa obliterans* may develop later, nodules of fibrous tissue replacing destroyed bronchioles. The X-ray findings resemble those of acinonodular tuberculosis.

Acute Suppurative Bronchitis

An epidemic of acute suppurative bronchitis occurred in the winter of 1916-17, but the disease is seldom, if ever, met with now. The

patient is extremely cyanosed and dyspnoeic, the sputum being thick and copious. The prognosis is very poor.

Acute Fibrinous Bronchitis

Some authorities regard this as a form of acute tracheobronchitis in which fibrinous casts form in the bronchial tree and are expectorated from time to time. The casts can be detected by floating the sputum in water. Attacks are liable to recur. Steam inhalations should be given, and benzylpenicillin, 1 million units (600 mg.), injected intramuscularly every 12 hours.

Chronic Bronchitis

Definition. Chronic bronchial inflammation.

Etiology. Chronic bronchitis may be a recurrent hibernal sequela of an acute attack of bronchitis which was not efficiently treated, or it may start insidiously. The organisms most commonly found in the sputum are the pneumococcus, *H. influenza*, *Staphylococcus aureus*, *Streptococcus hæmolyticus* and *Klebsiella pneumoniae* (Friedländer's bacillus), any of which may be pathogenic. Tuberculous bronchitis is described on p. 169. In some instances chronic bronchitis is secondary to cardiac or renal disease, or to infection in the naso-pharynx or cranial sinuses. *Predisposing causes:* 1. Age: Usually over 40. 2. Sex: Males predominate. 3. Climate: Damp and fog. 4. Season: Late autumn, winter and spring. 5. Habits: Cigarette smoking. 6. Dusty occupations. The professional classes are the least affected, the unskilled workers the most.

Pathology. In the early stages there is hypertrophy of the goblet cells in the bronchioles and of the mucous glands in the bronchi. The ducts of the mucous glands dilate. Later, various changes occur, such as purulent bronchiolitis, minute abscess formation, obliteration of bronchioles, dilatation of other bronchioles, and small areas of collapse and of emphysema.

Clinical Findings. The patient is often an adult male, over the age of 40, who gives a history of recurrent bronchitis every winter. He complains of cough, shortness of breath, and expectoration.

On Examination: There is often slight cyanosis of the face, and the fingers may be clubbed. The chest. Inspection: Movement is restricted, especially if there is emphysema. Palpation: Rhonchal fremitus may be present and tactile fremitus diminished. Percussion: The note is hyperresonant, and the area of cardiac and hepatic dulness is often encroached on by the emphysematous lung. Auscultation: The breath sounds are harsh or weak, and expiration is usually prolonged. Scattered rhonchi or râles may be heard. In some cases the adventitious sounds are only audible when the patient lies down, or after exertion. The vocal resonance is either normal or diminished. Right-sided cardiac dilatation may be present. *Cough syncope* may occur causing temporary loss of consciousness. This is due to cerebral anoxia, resulting from the strain of coughing raising the intrathoracic pressure. This reduces the return of blood to the heart, and the cardiac

output and blood pressure fall. The sputum: This may be scanty, and in the form of sticky masses or it may be abundant. It may be mucoid or purulent. The dyspnoea is due to bronchial spasm, sputum retention, and emphysema. Streaks of blood may be present from time to time. In only about 15% of cases of chronic bronchitis is there X-ray evidence of emphysema. The respiratory function tests show deficiency in the vital capacity, the forced expiratory volume and time, and peak flow rate. Bronchography shows some abnormality in 80% of cases, the changes including abnormal variation of the bronchus calibre on respiration, localised beaded bronchial dilatation, bronchial diverticula and poor filling of the smaller bronchi.

Differential Diagnosis. This usually presents no difficulty. Tuberculosis should be excluded by an X-ray and sputum test, and a bronchogram may be required in doubtful cases of bronchiectasis. Early hypertensive left-sided cardiac failure may be mistaken for chronic bronchitis.

Course and Complications. The course is progressive, with seasonal intensification. In the early stages the bronchitis is only present in the winter; later it persists, to a milder degree, through the summer. Complications include emphysema, asthma, bronchiectasis, dilatation of the heart, confusion and coma. Chronic bronchitis with emphysema is sometimes referred to as chronic obstructive bronchopulmonary disease.

Prognosis. This is usually unfavourable especially if the sputum remains purulent.

Treatment. If possible, the patient should winter in a milder climate abroad. Any septic focus in the nasopharynx should be removed. In England an outdoor occupation, or one involving the inhalation of smoke or dust, is unsuitable. The patient should give up smoking, and if obese, he should diet to reduce weight. If the sputum is difficult to bring up, the hot-water medicine is helpful. This contains Sod. chlorid. 3 gr. (0.2 G.), sod. bicarb. 5 gr. (0.3 G.), sp. chlorof. 5 m. (0.3 ml.), aq. anisi dest. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) in 1 fl. oz. (30 ml.) of hot water on rising, and repeated during the day if required. When the sputum is purulent ampicillin (Penbritin) 250 mg. capsules should be given, 4 capsules 6-hourly for at least 7 days. The sputum should now be mucoid. If it is still purulent the ampicillin should be given for another 7 days. If it is still purulent the treatment has failed. If the sputum is mucoid the treatment can be repeated later if the sputum becomes purulent again.

If the disease is complicated by bronchial spasm, antispasmodics should be given, as for asthma, and if there is bronchiectasis, daily postural drainage should be encouraged, with expiratory breathing exercises.

Chronic Obstructive Bronchitis

This has been defined as "chronic bronchitis in which there is persistent, widespread narrowing of the intra-pulmonary airways, at least on expiration, causing increased resistance to air-flow." It is the

main cause of dyspnoea in chronic bronchitis. The change in obstructive airway disease is only partially reversible. In some cases casts can be washed out by bronchial lavage.

Chronic Suppurative Bronchitis

In this variety of chronic bronchitis the bronchial secretion is retained for a time in some of the bronchi and becomes offensive. It may give rise to periodical unexplained rises of temperature, and resemble the early stages of bronchiectasis.

Chronic Fibrinous Bronchitis

The patient, who is a sufferer from chronic bronchitis, may from time to time have an attack of dyspnoea or a sense of constriction in the chest, which is relieved by the expectoration of a fibrinous bronchial cast.

Bronchiectasis

Definition. Dilatation of the bronchi.

Etiology. There are three main etiological factors : 1. *Mechanical.* Collapse of a bronchus, either by partial obstruction from within or by pressure from without, causes a fall of the intrapleural pressure with secondary dilatation of the adjacent bronchi, resulting in bronchiectasis. The causes include inhalation of a foreign body. Pressure of an aneurysm, tumour or calcified tuberculous lymph nodes may also cause collapse. Pulmonary fibrosis associated with pleural adhesions may by traction lead to bronchial dilatation. This may follow pneumonia or bronchopneumonia, syphilis or tuberculosis of the lungs, or be secondary to chronic pleurisy or penetrating chest wounds.

2. *Infective.* The bronchial wall may be weakened by chronic intrabronchial suppuration, and this, together with a persistent cough, may lead to bronchiectasis. It may thus be associated with the inhalation of septic matter into the bronchi, with chronic suppurative bronchitis and with lung abscess. Factors 1 and 2 are often combined but infection is the more important.

3. *Congenital.* This may be an error of development or due to atelectasis at birth. In Kartagener's syndrome there is congenital dextrocardia and absent or incomplete development of the frontal sinuses. Bronchiectasis associated with fibrocystic disease of the pancreas has been described on p. 73.

Pathology. The bronchial dilatation may be: 1. *Cylindrical, tubular or rat-tail.* This dilatation is uniform or narrower at its termination. 2. *Fusiform or glove-finger.* The dilatation is wider at its termination. This occurs especially in a collapsed lung. 3. *Saccular or globular.* This resembles a bunch of grapes. 4. *Moniliform or bead-like.* This suggests strung beads. The left lower lobe is most often affected.

Clinical Findings. The patient is usually a child or a young adult, although bronchiectasis may exist in elderly patients who are considered to be suffering from chronic bronchitis. There may be a history of some antecedent causative condition such as pneumonia or bronchopneumonia

The patient notices first that he has a cough, and the sputum may contain small amounts of offensive material, or it may be noticed that the breath is offensive after coughing, or that the sputum or cough is influenced by change of posture. This probably represents a pre-bronchiectatic stage, in which a bronchogram may reveal no abnormality. The amount of sputum gradually increases and is more persistently offensive. In other cases periodical unexplained rises of temperature with bronchitis may be the only symptom, or there may be recurring hæmoptysis, without any other symptoms (*forme hémoptoïque sèche*). In an established case the patient may say that life is unbearable owing to the amount of sputum and its horrible odour. Such cases are rare now.

On Examination: In an early case. The characteristic signs are the offensive nature of the sputum or of the breath, but both of these may be absent. The chest. There may be slight dullness at one base with weaker breath sounds and a few persistent râles. *In an established case.* There is usually evidence of toxæmia, as shown by wasting, or stunted growth in a child, cyanosis and clubbing of the fingers and toes. The chest. The signs are those of fibrosis and excavation. Inspection: Movement may be less on the affected side. Palpation: Vocal fremitus is diminished, usually over the affected area. The cardiac apex may be displaced to the side of the lesion. Auscultation: The air entry is usually weak over the bronchiectatic area, and some leathery, creaking or fibroid râles may be heard. If there is a cavity which is comparatively empty and in communication with a bronchus, the breathing may be bronchial or cavernous, with bronchophony and whispering pectoriloquy. Coarse râles may be heard. If the cavity is full there is dullness, with weak breath sounds and diminished voice conduction. The sputum: Expectoration is affected by change of posture. Thus it may come up chiefly on rising in the morning or on lying down at night. It is offensive. The amount may vary from about 1 to 20 fl. oz. (30 to 600 ml.) or more in the 24 hours. On standing in a conical vessel it may settle into three layers, frothy above, turbid in the centre and a deposit below. In the deposit the evil-smelling Dittrich's plugs may be found. Frequently the sputum is uniformly thick greenish pus. The *H. influenza* is often found in the sputum. Hæmoptysis may occur from time to time. The temperature chart may show rises corresponding with periods of retention of secretion, and falls when the expectoration is more profuse. A direct X-ray of the lungs may afford some suggestion of dilatation of bronchi, which may be confirmed by tomography, but an X-ray after intratracheal injection of iodised oil will reveal the outline of the bronchi and thus establish the diagnosis.

Differential Diagnosis. The diagnosis usually lies between a condition of suppurative bronchitis, interlobar empyema, a lung abscess, congenital cystic disease of the lungs, bronchial carcinoma or pulmonary tuberculosis and various causes of recurrent pyrexia. The bronchogram enables the diagnosis of bronchiectasis to be made.

Course and Complications. The course is usually progressive for a

time and then a stationary stage is reached. There is a great tendency for the other lung to become similarly affected. Complications include septicæmia, amyloid disease, cerebral or spinal cord abscess, empyema, pyopneumothorax, suppurative pericarditis or gangrene of the lung.

Prognosis. This has been much improved by antibiotic treatment, but if the disease is firmly established and widespread the outlook is very grave.

Treatment. Prophylactic: Breathing exercises to expand the base of the lung should be carried out during convalescence in every case of pneumonia, bronchopneumonia or empyema. Great care should be taken in operations on the nose and throat to prevent the inhalation of tissue from the operation site.

Curative: Cases should be diagnosed early and medical treatment instituted at once, thus avoiding the necessity for surgical operations. Postural drainage, as described below, should first be tried. The sensitivity of the predominating organisms in the sputum should be determined and periodical courses of the appropriate antibiotic given for 2 to 3 weeks. Postural drainage carried out regularly for half an hour 2 or 3 times a day may keep the bronchi dry. The patient must be prepared to continue postural drainage indefinitely. It can be carried out simply by lying face downwards over a stool about 2 feet (60 cm.) high, with the ribs clear of the seat of the stool, the head hanging down, and the hands on the floor. A basin is put on the floor to receive the sputum as the patient breathes deeply and coughs. In more severe cases tilting may be required for longer periods or by night as well as by day. The correct position can only be determined after studying the bronchograms, the object being to ensure that the pus in the affected bronchi drains downwards into the trachea. More than one position may be required to drain all the affected bronchi. The foot of the bed can then be raised on blocks or a special bed used, or more simply a metal bed elevator can be employed. The foot of the bed can thus be adjusted at different heights. A mixture of creosote and potassium iodide may be given if the sputum is offensive such as Pot. iod. 5 gr. (0.3 G.), creosot. 2 m. (0.12 ml.), tnc. quillaie 2½ m. (0.15 ml.), ext. glycyrrhiz. liq. 20 m. (1.2 ml.), syr. tolu. 30 m. (2 ml.), aq. anisi dest. ad ½ fl. oz. (15 ml.). ½ fl. oz. (15 ml.) ex aq. t.d.s. p.c. In cases of bronchiectasis due to the inhalation of a solid foreign body, bronchoscopy, with removal of the causative object, should be performed if possible. Repeated bronchoscopic drainage does not afford much hope of a cure.

Surgical treatment of bronchiectasis may imply segmental or lobar resection or total pneumonectomy. In some cases removal of portions of both lungs may be necessary. The number of operations for bronchiectasis is steadily diminishing, owing to improvements in the prophylaxis and medical treatment of pulmonary diseases.

Bronchial Diverticula

Bronchial pouches, resembling those described as tracheal diverticula (see p. 135), are rarely seen.

Asthma

(Spasmodic Asthma)

Definition. Paroxysmal attacks of dyspnoea, chiefly expiratory in nature, associated with bronchial spasm.

Etiology. The allergic diathesis is an important factor. Emotional factors, an over-anxious parent, domestic unhappiness, worry and anxiety may all play their part in inducing an attack.

Spasm of the bronchi may result from: 1. Emotions, fatigue, or the sight of artificial flowers. 2. Reflex stimulation, especially from the nose, and at times from the eye, stomach, and intestines. 3. Bronchial stimulation from the inhalation of cold air or fog. 4. Injected substances, such as acetylcholine or histamine, carried by the blood to the bronchi. 5. Inhibition of the sympathetic nerve supply, as by endocrine influences. 6. The effect of the adrenal corticoids is now assuming greater importance. Ovarian asthma occurs in the premenstrual period, and is due to lack of progesterone.

Œdema of the bronchi may result from: 1. Inhaled allergic substances such as pollens, room dust, book dust, orris-root powder, animal emanations, flower emanations, drugs, etc. Printers' asthma has been described, due to inhalation of gum acacia in the spray fluid used in colour printing. 2. Blood-borne allergic substances such as digestive products of foods, especially of eggs, milk, fish, cheese, etc., drugs taken by mouth, bacterial products liberated from foci of infection, injected serums and skin-testing materials.

Relaxation of the bronchi may result from: 1. Stimulation of the sympathetic nerve supply. 2. Inhalation of substances such as stramonium and adrenaline. 3. Blood-borne stimuli such as adrenaline which has been injected or ephedrine taken by mouth (see Fig. 18).

Predisposing Causes: 1. Heredity: Asthma often runs in families, the allergic diathesis being inherited. 2. Sex: Males predominate. 3. Age: Attacks usually start in childhood or early adult life.

Pathology. During the attack there may be constriction of the bronchial muscles with expiration, and, in addition, hyperæmia or œdema of the mucous membrane, with an increased output of mucus at the end of the attack. The lungs become overdistended as the air enters comparatively easily, but is expelled with difficulty. This leads to emphysema. Patients do sometimes die in an attack of bronchial asthma, and on post-mortem examination the bronchi may be filled with tenacious exudate. Polyarteritis nodosa is found in some cases. There may be secondary emphysema and dilatation of the heart.

Clinical Findings. The patient may give a history of eczema in childhood, or of a severe attack of bronchitis or bronchopneumonia which has been followed by asthma. In a typical case the attacks occur by night, the patient going to bed apparently well and waking about 2 a.m. with shortness of breath. He sits up in bed or may try to get near an open window. There is great distress. Asthma may recur at

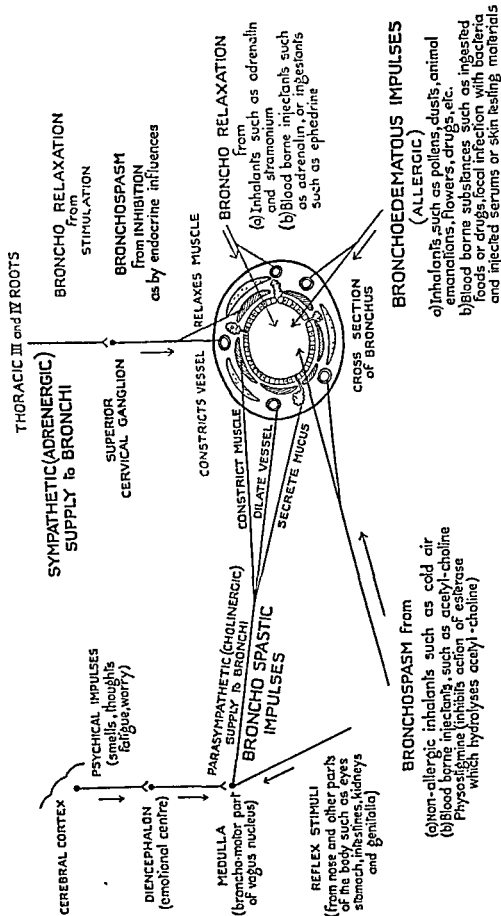


FIG. 13. DIAGRAM OF THE PATHS OF IMPULSES IN ASTHMA.

week-ends. This may be due to uncongenial home surroundings or personal relationships.

On Examination: During an attack. The patient usually sits forward with the head resting on the hands and the elbows on the knees. The face is pale and the expression anxious or alarmed. There may be cyanosis of the lips and ears. The breathing is laboured, short and jerky, inspiration being followed by very prolonged and feeble expiration. The accessory respiratory muscles come into play. The chest. Inspection: The movements described above will be noted. Palpation: Rhonchal fremitus may be felt. Percussion: The note is hyperresonant and the cardiac and liver dullness may be diminished. Auscultation: Expiration is prolonged, rather high-pitched and wheezy, and scattered rhonchi may be heard. Vocal resonance is usually diminished. The pulse is rapid and often weak during the attack. The blood may show an eosinophilia, up to 50%.

The attack usually stops gradually with cough and some expectoration. In the sputum Curschmann's spirals may be found, consisting of small coiled threads of mucus with leucocytes and eosinophil cells. Octahedral Charcot-Leyden crystals, formed of spermin phosphate, may also be present in the sputum. The attack may last for 2 hours or longer, and the patient remain wheezy for 1 or 2 days. After the attack he often falls asleep exhausted. *Between the attacks.* There may be no abnormal signs found in the lungs, but in a long-standing case there is usually emphysema and the chest is deformed, the shoulders being high and square, and the upper dorsal spine kyphotic.

Differential Diagnosis. Other types of paroxysmal dyspnoea must be excluded. Cardiac asthma: There is usually a lesion of the heart with or without congestive failure. The breathing tends to be less laboured, but more rapid. Renal asthma: There is usually a history of chronic nephritis and the urine contains protein. Bronchial asthma: The patient is a subject of chronic bronchitis and suffers from periodical attacks of asthma. Other causes of dyspnoea, such as an enlarged thymus or thyroid, or a loculated spontaneous pneumothorax compressing the upper half of the sound lung when the other one is extensively damaged by fibrosis, may closely simulate asthma.

Course and Complications. The course in adults is usually progressive, the attacks becoming more frequent unless some effective means are found for checking them. In some cases an attack may last for 2 or 3 weeks, a condition designated as the *status asthmaticus*. In children asthma may cease spontaneously for no apparent reason. Complications include emphysema, bronchitis, and dilatation of the heart. Subcutaneous emphysema is a rare complication, probably due to rupture of distended marginal vesicles. Pulmonary tuberculosis may be associated with asthma. Asthmatics are especially liable to anaphylaxis, and serum should not be administered for the treatment of other diseases without preliminary desensitisation on account of the danger of the patient passing into *status asthmaticus* and dying within 24 hours.

Prognosis. Death during an attack is not so uncommon as was at

one time thought. Asthma tends to shorten life owing to the complications, and is a very crippling disability. Death may occur from right heart failure, spontaneous pneumothorax, or from suffocation due to blockage of the small bronchi by mucus.

Treatment. *During the attack:* At the first symptom 2 to 4 m. (0.12 to 0.25 ml.) of inject. adrenaline (B.P.) 1 in 1,000 should be injected subcutaneously or an isoprenaline sulph. (Neo-Epinephrine) tablet, 20 mg., dissolved under the tongue. An oral inhaler may be used, charged with an aerosol of isoprenaline, either 0.4 mg. or 0.08 mg. in each dose. With some patients a tablet of ephedrine hydrochloride $\frac{1}{2}$ gr. (50 mg.) taken by mouth will ward off an attack. An inhalation of amyl nitrite 5 m. (0.3 ml.) from a capsule sometimes gives relief. Other methods include the intravenous injection of aminophylline 250 mg. to 500 mg. in 10 ml. saline slowly, or an aminophylline, 350 mg., suppository per rectum. For the milder attacks anything which distracts the mind may afford relief. Thus one of my patients said to me "The best cure for my asthma is a game of Bridge, especially when I win." For the *status asthmaticus* a syringe should be filled with 2 ml. inject. adrenaline (B.P.) 1 in 1,000 and 0.1 ml. injected subcutaneously every 5 minutes, keeping the needle in position; the attack may be terminated in some cases in half an hour by this method. In an elderly male patient with an enlarged prostate adrenaline may cause retention of urine. Some patients suffering from the *status asthmaticus* are not relieved even by repeated injections of adrenaline. In these cases oxygen should be given by a plastic mask at the rate of 6 to 9 litres a minute. Morphine or pethidine may result in respiratory failure and should not be used. Corticosteroids should be given in severe cases of asthma, in the form of prednisolone, 5 mg. tab., or betamethasone (Betnelan) 0.5 mg. tab., two tabs. 6-hourly, with gradual reduction of the dose. A more rapid effect can be obtained by the intravenous injection of hydrocortisone hemisuccinate 100 mg. in 2 ml. Bronchial lavage under general anaesthesia has also been used. If sleep is prevented by fear of an attack, phenobarbitone, $\frac{1}{2}$ to 1 gr. (30 to 60 mg.), should be given at night. Amesec, which contains aminophylline, ephedrine and amytal, 1 capsule at night may also be helpful. A patient taking monoamine-oxidase inhibitors must not have injections of adrenaline, noradrenaline, amphetamine, or isoprenaline as they raise the noradrenaline store in the body and lead to hypertension. These drugs may be given by mouth or by inhalation. *Between the attacks:* In all cases of asthma it is advisable to examine the patient, and not merely his skin reactions. A search for a septic focus should first be carried out, with investigations of the throat, cranial sinuses and antra, teeth, faeces and urine. The lungs should be examined radiologically to determine the degree of emphysema and to exclude tuberculosis. The vital capacity should be estimated. This is reduced, as are also the F.E.V.₁ and the peak flow rate. The arterial pO₂ is low. The sputum should be examined for tubercle bacilli and for the predominating organisms. When the sensitivity of the organism has been determined the appropriate antibiotic should be given for 1 to 2 weeks. An investigation should be carried out as to the

relation of the asthma to locality, foods, seasons, animals, flowers, plants and injections. The benefit obtained in some cases by a holiday in Switzerland or a week-end by the sea may be due rather to the change of society than to the change of locality. The cutaneous protein reactions should be determined. Many cases of asthma are due to room dust or feathers, and some to face powders and cosmetics. The bedroom should be sparsely furnished, with no carpet, no covering to the chairs, and the lightest of curtains. Kapok pillows, bolster and quilt, and a rubber mattress should be used. The room should be kept scrupulously free from dust with a vacuum cleaner and a damp cloth.

In *premenstrual asthma* the patient should be given an intramuscular injection of 1 ml. of Disecron (progesterone 12.5 mg. and œstradiol monobenzoate 2.5 mg.) every other day for 5 doses, beginning 7 days before the period is due, and repeated each cycle for a few months.

In bronchial asthma a course of potassium iodide and stramonium should be given, such as Pot. iod. 3 gr. (0.2 G.), tnc. stramon. 10 m. (0.6 ml.), ext. glycyrrhiz. liq. 20 m. (1.2 ml.), sp. chlorof. 5 m. (0.3 ml.), aq. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s. This should be taken for a month and then continued once or twice daily if it affords relief. In cases of allergy other than bacterial, it is best, if possible, to avoid the substances to which the patient is sensitive. Face and talcum powders free from orris-root are obtainable. An enquiry should be made as to whether or not the patient is sensitive to aspirin. If he can take aspirin without cardiac disturbance, 1 or 2 tablets at night will sometimes prevent an attack. Expiratory breathing exercises are of value in all cases of asthma, and a course, as described in the Asthma Research Council booklet, should be carried out. No rules can be laid down as regards locality for residence, as individuals vary so much, but many asthmatic patients are free from attacks at an altitude of over 4,000 feet (1,320 metres). An asthmatic patient who is definitely emphysematous will probably be unable to tolerate such an altitude.

Bronchial Obstruction

Etiology. The obstruction may result from causes within the bronchi, changes in their walls, or pressure from without. 1. *Within the bronchus* : The obstruction may be due to thick mucus, to an inhaled foreign body, to substances entering through a tracheostomy wound, or to a lymph node ulcerating through the bronchial wall. 2. *In the wall of the bronchus* : Tuberculosis or syphilis may cause fibrosis, or a scar may result from a foreign body which has been removed, or from inhaled irritants. Adenoma and bronchial carcinoma are important causes. Muscular spasm is a factor causing obstruction in asthma. 3. *Outside the bronchial wall* : Pressure on the bronchi may be exerted in the mediastinum by enlarged lymph nodes, a tumour, an aneurysm, an abscess, carcinoma of the œsophagus, or by a pericardial effusion. Intrapulmonary tumours or an interlobar effusion may also cause bronchial obstruction.

Pathology. Bronchial obstruction leads to varying degrees of collapse of the pulmonary territory. If the obstruction is due to a septic foreign body, then bronchitis, bronchopneumonia, bronchiectasis, pulmonary abscess, or gangrene may ensue. An inhaled foreign body is rather more likely to pass to the right lung than to the left, as the junction of the right bronchus with the trachea is slightly wider, and at a less acute angle than is that of the left bronchus.

Clinical Findings. If the patient has inhaled a foreign body, which lodges in a bronchus, he usually complains of cough and perhaps a little discomfort in the chest. A variable latent period may now occur before septic symptoms appear. Often the first symptom noted is that the breath is offensive after coughing, and then a little ill-smelling sputum is brought up. The patient becomes more acutely ill with cough, expectoration and fever.

On Examination : A small area of dulness and bronchial breathing with a few fine râles may be found. The physical signs in any individual case vary with the degree of obstruction and the amount of sepsis. Thus a foreign body, such as an acorn, may obstruct the orifice of the main bronchus going to one lung. The whole lung will then collapse, with consequent diminution of expansion on that side of the chest, weak or absent air entry, increased voice conduction and displacement of the heart to the affected side. In other cases signs of pulmonary abscess or of bronchiectasis develop. The chest should be X-rayed and in this way a solid foreign body may be revealed. A bronchogram will indicate the site of bronchial obstruction. If this is intrapulmonary and not due to a foreign body, bronchoscopy will probably be necessary to decide whether the bronchial obstruction is due to an intrabronchial cause, such as a primary carcinoma of the bronchus, or to an intrapulmonary but extra-bronchial cause, such as a tumour of the lung.

Differential Diagnosis. There is usually little difficulty in diagnosis in cases of an inhaled foreign body. A history of an operation on the nose or throat, which is shortly followed by cough with fetid breath and offensive sputum, is typical of bronchial obstruction due to an inhaled septic foreign body. Bronchial obstruction due to other causes is usually diagnosed by means of the investigations detailed above.

Course and Complications. These vary with the cause, the complications have been mentioned above.

Prognosis. A foreign body usually causes little trouble if it is a hard object which can be readily removed. The outlook is serious with soft and septic foreign bodies. The prognosis is grave with cases due to a new growth.

Treatment. A hard foreign body should be removed with a bronchoscope. The treatment of the other varieties should be directed to the causative factor.

Tumours of the Bronchi

Simple Tumours. These include adenoma, papilloma, lipoma, myxoma, fibroma, chondroma and amyloid deposits.

Malignant Tumours. The growth is usually a primary carcinoma. Secondary carcinoma may also involve the bronchi. Sarcoma is rare.

Adenoma of the Bronchus

Pathology. A small polypoid tumour arises, usually in mucous glands in a main bronchus, but occasionally in a tertiary bronchus. It is generally smooth, shiny and very vascular, and the greater part of the tumour is situated in the wall of the bronchus, only a small portion projecting into the lumen. It was formerly mistaken for carcinoma owing to the staining peculiarities of certain of its cells and their irregular distribution in the connective tissue. Metastases have occasionally been recorded, which suggest the tumour may be potentially malignant, hence the alternative name carcinoid bronchial adenoma.

Clinical Findings. The patient is usually an adult under the age of 40. It is more common in women. Hæmoptysis of varying degree is often the earliest symptom. In other cases dry pleurisy, pleural effusion or empyema may be first noted. If the tumour causes bronchial obstruction there is wheezing, pulmonary collapse, or bronchiectasis.

Differential Diagnosis. This includes other causes of hæmoptysis, pulmonary collapse, or bronchiectasis. In cases complicated by pleural effusion the underlying cause is likely to be overlooked. A coin-shaped lesion, as shown on tomography, may be due to an adenoma, a tuberculoma or to endometriosis. The diagnosis is established by microscopical examination of a piece of the tumour removed through a bronchoscope.

Prognosis. Cases diagnosed early can usually be treated successfully.

Treatment. There is a risk of fatal hæmorrhage if removal is attempted by forceps through a bronchoscope or by diathermic coagulation. Lobectomy is the usual treatment.

Primary Carcinoma of the Bronchus

Etiology. The cause is not definitely known, but the incidence of carcinoma of the bronchus has greatly increased during the past 20 years. It is thought that inhalation of irritants is an exciting cause, particularly that resulting from cigarette smoking. Statistics indicate that there is a grave danger of contracting the disease if an individual smokes over 20 cigarettes a day for a period of years. The risk from pipe or cigar smoking is considerably less. It has also been shown that the sex incidence of bronchial carcinoma in non-smokers is equal. As bronchial carcinoma occurs in non-smokers, smoking cannot be the sole cause. The disease is more common in urban than in rural areas, and a smoky atmosphere may contain a carcinogenic agent. However, the death rate from lung cancer in males is the highest in the world in Jersey, Channel Islands, and more tobacco is smoked per head of population there than elsewhere. There is no definite evidence that tar, dust, petrol or diesel oil fumes are exciting causes. Other causes which have been postulated include arsenic in nickel workers, arsenic administered medicinally, mustard-gas poisoning, asbestos, and the fumes connected

with coal gas manufacture. The radio-active dust from certain mines is also carcinogenic. The growth may arise in lung scars and in chronic lung cavities. *Predisposing causes* : 1. Age : The maximum incidence is between 40 and 55 years. 2. Sex : Males predominate.

Pathology. It is now generally agreed that primary carcinoma of the lung actually arises in a bronchus from an undifferentiated cell in the basal layer of the epithelium. The tumour may be squamous-celled, an adeno-carcinoma or an undifferentiated round-cell, spindle-cell or "oat-cell" growth. In about 75% of cases the tumour arises in a main stem bronchus and is then usually squamous-celled; the remainder originate in the small peripheral bronchi, the squamous-celled variety preponderating to a lesser degree. Central necrosis and involvement of the pleura or thoracic wall tend to occur in the peripheral variety. Tumours situated centrally may rapidly spread to the mediastinal tissues, giving rise to a hilar or mediastinal type. In other cases diffuse infiltration of lung tissue may occur.

Clinical Findings. The patient is usually a middle-aged adult who has suffered from a smoker's cough for some years. This may have become worse recently. In the early stages he appears in good health. Wheezing may be an early symptom. In the peripheral type especially, a few streaks of blood or a small clot may be coughed up, or pain in the chest may be complained of. When the disease becomes more advanced certain clinical types can be recognised. (a) *Dependent on the primary growth.* 1. *Pulmonary* : The chief symptoms are cough, expectoration, pain in the chest, and dyspnoea. There is loss of weight, anorexia, sweating, and febrile attacks. In some cases in which infection has occurred the onset is acute, resembling influenza, bronchopneumonia or lung abscess. 2. *Mediastinal* : The clinical picture resembles that of mediastinal pressure or of right-sided heart failure. There may be dyspnoea, a brassy cough, an asthmatoïd wheeze, cyanosis, venous engorgement, and œdema of the legs. (b) *Dependent on the secondary deposits.* The primary lung tumour remains small and symptomless and may not be revealed by X-ray examination. 1. *Nervous* : Secondary deposits in the brain may suggest a primary cerebral tumour, hæmorrhage or abscess, encephalitis, diabetes insipidus, or meningitis. Pressure of secondary deposits may also cause brachial or sciatic neuritis. 2. *Osseous* : Pains in the bones or spontaneous fractures occur in about 80% of cases. 3. *Gastro-intestinal* : Metastases in lymph nodes or in the liver may result in prolonged fever, sweating, dysphagia, jaundice, hæmatemesis or melæna. 4. *Lymphatic* : Enlargement of the supra-clavicular, axillary or cervical lymph nodes may suggest Hodgkin's disease.

Peripheral neuritic symptoms, swelling of the joints simulating rheumatoid arthritis, and pulmonary osteo-arthropathy may appear apart from secondary deposits.

The Pancoast tumour is the name applied to an apical or superior pulmonary sulcus carcinoma. The characteristic features are pain in the region of the scapula and medial side of the arm, with wasting of the small muscles of the hand. There is also homolateral cervical

sympathetic paralysis characterised by enophthalmos, a small pupil and ptosis (Horner's syndrome). Dulness is found at the apex of the lung and X-ray examination shows a small circumscribed apical opacity with destruction of the posterior part of the first three ribs.

On Examination : In the early stage the patient often looks well and no physical signs can usually be found, and in the main stem type, before any pulmonary collapse has occurred, X-ray examination of the chest is usually negative. Clubbing of the fingers may rapidly develop. With a peripherally situated growth X-rays may reveal a shadow due to a small area of collapsed lung. With the main stem bronchus type the physical signs which develop vary with the degree of obstruction present. With partial obstruction there is slight dulness and weak air entry over the affected part of the lung. With a ball-valve obstruction the percussion note becomes boxy from over-distention of the lung, and expiration is prolonged and wheezy. With complete obstruction the affected part collapses, with absent breath sounds and possibly displacement of the mediastinum to the affected side. In the peripheral type the signs may suggest infiltration, consolidation or abscess formation, or they may be those of dry pleurisy or of pleural effusion. In the latter case exploration may reveal a serous, hæmorrhagic or purulent effusion. Cardiac irregularities may be due to involvement of the pericardium or heart muscle. With the central type the physical signs in the lungs may be very slight, over a root area posteriorly. Pressure may cause collapse, often of a lower lobe bronchus and further evidence of the mediastinal syndrome may be revealed (see p. 213). The barium swallow may show deviation of the œsophagus, indicating not only mediastinal lymph node involvement, but also inoperability. Later, the signs of infection of bronchi, or of spread of the growth in the lung, or of metastases may be found. The mass of growth may extend so that it is palpable above the clavicle, or it may ulcerate through the chest wall. The sputum : This may be scanty and tenacious, or it may be red, resembling "red currant jelly," or darker like "prune juice." Carcinoma cells have been found in the sputum in about 60% of cases by some observers. The blood : In the later stages there is a microcytic anæmia. Leucocytosis is not the rule unless there is secondary infection. X-ray examination : The shadow of the growth is only revealed in a minority of cases. There is more often a homogeneous shadow due to an atelectatic area of lung, and with infection this may become mottled or show cavity formation. The walls of the cavity may be thickened and irregular. Tomograms should always be taken. The mediastinum may be displaced slightly to the affected side and the corresponding diaphragm raised. The picture may be obscured by a pleural effusion ; in such instances the fluid should be aspirated and replaced by air, when the growth may be revealed by X-ray examination or by thoracoscopy. A bronchogram may then reveal a blocked bronchus. Bronchoscopy : This should be advised in all suspected cases of early carcinoma. In about 25% of cases, however, the growth is not visible owing to its peripheral distribution. In some cases of peripheral growth thoracotomy may

be necessary to enable a specimen to be removed for microscopical examination.

Differential Diagnosis. This is difficult in the early stages. A persistent dry cough or an increase of a chronic cough should not be dismissed as of no consequence, and wheezing should not necessarily be attributed to asthma. If the symptoms suggest an early lesion, bronchoscopy should not be postponed until the development of advanced signs renders radical treatment impossible. The Wassermann reaction should be determined to eliminate the possibility of a gumma. The satisfactory response to anti-syphilitic treatment in cases which give a positive reaction will help to confirm the diagnosis of a gumma. I have seen such a case. The presence of tubercle bacilli in the sputum does not negative the possibility of bronchial carcinoma, as tuberculosis and carcinoma may coexist. This also applies to the presence of a lung abscess. A mesothelial mediastinal cyst—the so-called spring-water cyst—seen on X-ray examination as a shadow in the right cardiophrenic angle, may be mistaken for a bronchial carcinoma. The chief symptoms may be distal, due to secondary deposits, as described above, or due to polyneuritis. Glycosuria may be discovered on routine examination, caused by secondary deposits in the pancreas. The irregular fever may suggest malignant endocarditis or Hodgkin's disease.

Course and Complications. The course is steadily progressive. Secondary deposits are liable to occur in lymph nodes, the liver, the kidneys, the adrenals, the brain, the eye (the fundi should always be examined), the spinal medulla (cord), and in bones. Complications include bronchitis, bronchiectasis, lung abscess and gangrene, pleural effusions, and hæmoptysis which may be fatal. The growth may directly invade the pericardium and atrium of the heart, resulting in cardiac arrhythmia. The carcinoid syndrome (see p. 60) may be associated with an oat-celled bronchial carcinoma. Bronchial carcinoma may also be associated with Cushing's syndrome, hyponatræmia, gynæcomastia and hypercalcaemia.

Prognosis. Death usually occurs in 8 to 22 months from the onset of symptoms, if surgical removal of the growth is not possible. The prognosis after resection is better in undifferentiated carcinoma than in oat-celled tumours. In the former 29% may survive for 5 years. If the patient continues to smoke after removal of one lung, he may return a year or so later with cancer in the other lung.

Treatment. In early cases, in which there are no secondary deposits, the whole lung may be removed by dissection pneumonectomy. An early tumour in the lower lobe can at times be removed by lobectomy. Contra-indications to pneumonectomy are heart disease, distant metastases, enlarged mediastinal lymph nodes, recurrent laryngeal nerve palsy, Horner's syndrome, and a hæmorrhagic pleural effusion. Diaphragmatic paralysis is usually a contra-indication, an inflammatory pleural effusion which is not blood-stained is not necessarily so, as it may be due to infection. An exploratory thoracotomy is indicated in some cases in which the diagnosis or the operability is in doubt. Neither

nitrogen mustard nor deep X-ray treatment offer hope of cure. Treatment in advanced cases is palliative, by sedatives such as diamorphin. hydrochlor. $\frac{1}{2}$ gr. (7.5 mg.) as required, for relief of cough and pain. Dyspnoea due to a pleural effusion may be relieved by aspiration.

Injury to the Bronchi

Rupture of a bronchus may result from severe external trauma to the chest wall, such as in a crushing accident. This is rapidly followed by surgical emphysema of the chest and neck, and death usually ensues in a short time.

THE LUNGS

Congenital Agenesis of a Lung

Rarely, one lung or a part of a lung is congenitally absent, the other lung showing compensatory hypertrophy. The chest appears symmetrical and the movement is equal on both sides, but there is considerable displacement and rotation of the mediastinum when the whole of one lung is absent. The trachea and heart are markedly displaced, the breath sounds being audible over the whole chest. Provided the patient survives the first year there appears to be no reason why the absence of the lung should cause death.

Other congenital abnormalities may be associated with the absence of a lung, such as ectopia of a kidney, an unicornuate uterus, an abnormally shaped skull, hypertrophy of adrenal, imperforate anus, etc.

Sequestration of a Lung

This is a congenital abnormality in which one or more segments of a lung are separated from the surrounding lung tissue. The affected portion of the lung has a rudimentary structure, the tissue often being undifferentiated. It may be solid or cystic. The sequestered portion is usually supplied by an anomalous artery, arising either from the aorta or the coeliac axis. The patient may complain of pain in the back, and on X-ray examination a shadow is seen, which may be mistaken for that cast by a neoplasm or atypical pneumonia. The sequestered tissue is prone to infection. An aortogram may demonstrate the anomalous artery and so confirm the diagnosis.

The Bacterial Pneumonias

Pneumonia and influenza are still important causes of death, especially in the aged and in infants. Pneumonia, whenever possible, should be classified etiologically, rather than anatomically, and for this reason there is a tendency to discard the older divisions into lobar and bronchopneumonia. The most important causes of pulmonary inflammation and pneumonia are the *Streptococcus pneumoniae*, or pneumococcus, the *Streptococcus haemolyticus*, the *Staphylococcus aureus* and the *Klebsiella pneumoniae* (Friedländer's bacillus). Over 90% of cases of pneumonia are due to the pneumococcus, and it gives rise to the most typical clinical picture.

Pneumococcal Pneumonia

Etiology. Over 75 types of pneumococci have been described, but as serum treatment has now been abandoned the actual type present in an individual case is of little moment. *Predisposing causes* : 1. The presence of pneumococci in the naso-pharynx. Probably over 50% of normal individuals are carriers of pneumococci. 2. Age : Children, young adults and old people. 3. Sex : Males predominate. 4. Season : Autumn and winter. 5. A previous attack. This predisposes to subsequent attacks. 6. Debility : Due to exposure, overwork and alcoholism.

Pathology. Pneumococcal pneumonia usually affects one or more lobes of the lung. Frequently, however, there are scattered areas of consolidation constituting what was known as bronchopneumonia. The affected lobe of the lung goes through characteristic changes. In the first stage there is active hyperæmia, this is followed by consolidation—red hepatisation. The third stage is known as grey hepatisation, and this is followed by resolution. It is rare for an abscess or gangrene of the lung to develop. Dry pleurisy is always found over the affected lung.

Incubation Period. This is probably from 1 to 2 days.

Clinical Findings. The patient is often an adult male of rather a robust type. There may be a history of exposure to cold or wet, but rarely of contact with another patient suffering from lobar pneumonia. He is suddenly taken ill with shivering, malaise and stabbing pain in the chest. The pain may be referred to the abdomen or to the tip of the shoulder if there is diaphragmatic pleurisy. A short dry and painful cough usually rapidly develops. In children the onset is often with a rigor or with vomiting.

On Examination : The patient looks ill, with a somewhat anxious expression, dry skin, flushed face and bright eyes. The breathing is shallow and rapid, and a grunting noise may be heard with expiration ; the *alæ nasi* muscles may be seen in action. The temperature is usually high, 102° or 104° F. (38.9° or 40° C.), the pulse frequent, 110 to 120, and the respiration rapid, 30 to 40. The pulse-respiration ratio may be 3 : 1, or even 2 : 1. The chest : There is diminished expansion on the affected side ; the percussion note may be slightly impaired over one lobe, the air entry there is weak, and a few fine râles or pleural crepitations may be heard. X-ray examination at this stage may reveal some deep-seated consolidation, which spreads outwards later. Usually on the second or third day definite signs of consolidation are found in the affected lobe. These signs are dullness, increased tactile fremitus, tubular breathing and fine "indurated" crepitations. The percussion note at the apex of the lung above the affected lobe may be skodaic. The urine may contain a trace of protein, with diminution or absence of chlorides. A small amount of tenacious blood-stained ("rusty") sputum is usually brought up on the second or third day, and the sputum continues during the course of the illness, but gradually becomes looser and free from blood. In other cases there may be a definite hæmoptysis with bright blood. Labial herpes is often seen during the early stages of the illness. The blood pressure is generally

low, and the blood count shows a leucocytosis of 20,000 to 30,000 per c.mm. in "sthenic" types with a good reaction.

The use of antibiotics has considerably modified the classical course of the disease. The classical picture is as follows: The temperature remains raised for 5 or 6 days, and then may fall to normal rapidly by crisis, or more gradually by lysis. At the crisis the patient's condition generally improves, there is sweating, and the toxæmic symptoms usually abate, but the patient remains exhausted, and collapse may occur with signs of heart failure. The physical signs of consolidation remain unchanged.

Shortly after the crisis the patient may become maniacal, but this does not usually persist for more than a day or so. As resolution occurs in the lungs there is an increase of the crepitations heard ("redux" crepitations) and the signs of consolidation gradually disappear.

Differential Diagnosis. The diagnosis of pneumococcal pneumonia is often a matter of no difficulty. In the early stages it may be confused with the onset of various acute illnesses, especially influenza and typhoid fever. The acute pain in the side suggests pleurisy; and this is almost invariably present in pneumonia. The initial fever and vomiting may suggest the onset of scarlet fever in children, but the diagnosis is soon established in the latter case by the appearance of the characteristic rash. Apical pneumonia may be mistaken for meningitis. The onset and early stages of acute pneumonic tuberculosis and of lobar pneumonia are very similar. In the former the temperature does not fall rapidly with treatment as it does in pneumococcal pneumonia, and tubercle bacilli are usually found in the sputum. When the pain in pneumonia is abdominal it may suggest an acute abdominal lesion, such as appendicitis. The increase in the respiration rate in pneumonia is an important diagnostic sign. Massive collapse of the lungs was formerly usually mistaken for post-operative pneumonia, but the displacement of the heart to the affected side in massive collapse and the course of the disease serve to differentiate the two. In paroxysmal tachycardia acute congestion may be found at the base of a lung suggesting early pneumonia, but a careful enquiry into the history of the illness and clinical examination establish the diagnosis. Early maniacal symptoms in lobar pneumonia may lead to an error in diagnosis. Primary atypical pneumonia may give rise to difficulty in diagnosis in some cases. In this condition headache is usually more severe and respiratory symptoms are less marked. Examination of the sputum shows the causative organism in bacterial pneumonias, and examination of the blood reveals the presence of cold agglutinins in primary atypical pneumonia.

Course and Complications. The classical stages are considerably modified by the early administration of penicillin and other antibiotics and to a less extent by the use of sulphonamides. If the penicillin injections are begun on the first day when the signs are slight, the temperature, pulse and respiration rates will often fall to normal within 48 hours. The general condition of the patient rapidly improves, pain disappears and toxic symptoms are abolished. On the second or third day, however, the physical signs of consolidation may be

marked despite the absence of all toxic signs. The following are the most important complications: Delayed resolution, pleural effusion (serous or purulent), an empyema may develop during the acute stage of the pneumonia (syn-pneumonic) or after the temperature has fallen to normal (meta-pneumonic), pericarditis (dry, serous or purulent), otitis media, endocarditis, meningitis, venous thrombosis, nephritis, colitis, peritonitis, jaundice, arthritis, parotitis, peripheral neuritis, abscess or gangrene of the lung. Fibrosis of the lung and bronchiectasis may occur as sequelæ.

Prognosis. This is usually good with the administration of antibiotics. The prognosis of staphylococcal and Friedländer pneumonias is much more grave than is that of pneumococcal pneumonia. The following are unfavourable factors: The extremes of age, a history of chronic alcoholism, coexisting diseases such as heart lesions, nephritis or diabetes mellitus, pregnancy, a severe degree of toxæmia, a low degree of fever and absence of response ("asthenic" type) as shown by a leucocyte count below 10,000 per c.mm. Double pneumonia or creeping pneumonia is more serious than when the disease remains confined to one lobe. Unfavourable signs are a falling blood pressure with rising pulse rate, progressive weakening of the heart with dilatation, marked cyanosis, and a respiration rate of over 50 a minute. Death usually occurs from vasomotor collapse with pneumococcal bacteriæmia.

Streptococcal Pneumonia

Etiology. The streptococcus is β -hæmolytic, group A. The disease is often secondary to acute infections, especially influenza and measles, or to hæmolytic streptococcal tonsillitis.

Pathology. The changes in the lungs are often widely scattered, assuming a bronchopneumonic distribution.

Clinical Findings. The onset is usually insidious, with bronchitis. If untreated the disease tends to progress rapidly, the patient being prostrated and toxæmic. Pleural effusion frequently occurs. Clinical examination reveals patchy areas of consolidation, with coarse râles.

Complications. Streptococcal septicæmia and empyema are likely to occur unless the disease is treated early and efficiently.

Staphylococcal Pneumonia

Etiology. The causative organism is the *Staphylococcus aureus*, type A, hæmolytic and coagulase-positive.

Pathology. There is a great tendency to abscess formation. Empyema and broncho-pleural fistula are not uncommon.

Clinical Findings. In adults the disease is often secondary to staphylococcal infection elsewhere, such as perinephric abscess or boils, but in many cases the primary focus cannot be found. It is also met with in infants, and, if the child survives, may lead to bronchiectasis or cystic changes in the lungs. The onset is insidious, but the disease tends to progress rapidly. High irregular fever with profuse sweating are characteristic features. When an abscess bursts into a bronchus pus is

expectorated. There is a tendency for the abscesses to leave thin-walled cavities, as shown by X-ray examination.

Friedländer Pneumonia

Etiology. This variety of pneumonia is due to infection of the lungs with *Klebsiella pneumoniae* (Friedländer's bacillus).

Pathology. There are numerous small areas of consolidation in the lungs, which tend to coalesce. They form small pulmonary abscesses.

Clinical Findings. The patient is often over middle age, and may be debilitated or a chronic alcoholic. The onset is usually acute, with fever, shivering attacks, and pains in the chest, due to pleurisy. There is copious purulent sputum. The disease rapidly progresses to a fatal issue if the appropriate antibiotic treatment is not given. On X-ray examination it is found that the disease tends to affect the upper lobe, with cavity formation, and in this respect it resembles pulmonary tuberculosis.

Prognosis. The mortality rate has been lowered from about 80% to about 20% with modern treatment.

Treatment

Pneumococcal Pneumonia. The patient should retire to bed at the earliest symptom. It is not possible at the first visit to know the nature of the causative organism. There may be no sputum for 2 or 3 days, and there may be no facilities for isolating the organism from the sputum and for determining its antibiotic sensitivity; in every case there will be a further delay before the result is obtained. Treatment, however, should begin as soon as the patient is seen. As in the vast majority of cases of bacterial pneumonia the causative organism is the pneumococcus, benzylpenicillin should be injected intramuscularly, 500,000 units (300 mg.) every 6 hours for 24 hours, then 500,000 units every 8 hours for 24 hours, and then 500,000 units every 12 hours for 24 hours. Procaine penicillin may now be injected intramuscularly, 600,000 units daily for about another 4 days. Penicillin may be given by mouth in doses five times as great as those used intramuscularly. Tablets contain 500,000 units. Alternatively, the patient may be given a sulphonamide such as sulphadimidine, the initial dose being 2 G., followed by 1 G. every 6 hours for 5 or 7 days. A tetracycline drug may be used, chlortetracycline (Aureomycin) or tetracycline (Achromycin). The dose is 500 mg. (2 capsules) every 6 hours for 5 to 7 days. Should diarrhoea occur with these drugs they should be discontinued. Vitamin B should be given in the form of Beplex capsules, 2 t.d.s.

The diet: A milk diet should be given during the acute stage. The patient should drink plenty of fluid, 5 to 6 pints (3 to 3.6 litres) a day, such as dextrose orangeade containing dextrose 4 oz. (120 G.) the juice of an orange and water a pint (600 ml.), barley water and broth containing 1% NaCl. The diet can usually be rapidly augmented by thin bread and butter and a lightly boiled egg and steamed fish. The bowels should be opened daily or every other day by a saline aperient, by cascara sagrada 2 gr. (0.12 G.), or by Cascara Evacuant 30 to 60 m.

(2 to 4 ml.), or an enema may be given, if necessary. Cataplasma kaolini may be applied to the chest on lint, over the affected portion of the lung and changed every 12 hours. A light gamgee jacket should be worn over this. If the pain in the chest is severe it can usually be rapidly relieved by strapping the affected side of the chest in a position of full expiration. Sleep should be secured by giving injections of Omnopon $\frac{1}{3}$ gr. (20 mg.) or by pulv. ipecac. et opii 10 gr. (0.6 G.) the first two evenings, and later by the use of two Soneryl tablets, $1\frac{1}{2}$ gr. (0.1 G.) each. In some cases of obstinate insomnia brandy 1 fl. oz. (30 ml.) in hot water at night acts like a charm. If the patient is an alcoholic, whisky or brandy $\frac{1}{2}$ fl. oz. (15 ml.) should be given four- to six-hourly. For the irritating cough a sedative linctus may be prescribed, such as syrup codein. phosphat. (B.P.C.) 60 m. (4 ml.) occasionally. Later, as expectoration loosens, a stimulating mixture should be given such as Ammon. carb. 5 gr. (0.3 G.), pot. iod. 3 gr. (0.2 G.), tnc. scillæ 20 m. (1.2 ml.), sp. chlorof. 7 m. (0.45 ml.), infus. senegæ rec. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s. If there is cyanosis oxygen should be given continuously through a nasal tube or mask. An oxygen tent is of great value for babies. A cuffed tracheostomy tube, connected with an intermittent positive pressure respiration apparatus, may be used to relieve obstruction due to thick mucus in the trachea and main bronchi. The frequency of respiration and the tidal volume is adjusted so that the patient just stops making respiratory efforts. The PCO_2 is thus adjusted to a satisfactory level. The inspired air is humidified, bronchial secretions aspirated, the patient turned from side to side every 2 hours, and every hour Polybaetrin is applied to the tracheostomy in aerosol form. The tube may be left in for about a week. Signs of cardiac dilatation or weakening of the pulse should be treated by the administration of such drugs as nikethamide (Coramine) 2 ml. subcutaneously four-hourly. Shock with peripheral vascular collapse should be treated promptly with the administration of oxygen. Noradrenaline should be given by continuous intravenous drip to maintain the systolic pressure between 110 and 100 mm. Hg. Great care must be taken not to overload the circulation if there is heart failure. The intravenous injection of 300 mg. hydrocortisone during the first 24 hours is of value in severe cases. Digitalis in pneumonia is only required for congestive failure or for atrial fibrillation or flutter. Flatulent abdominal distention must be treated early, as it embarrasses both heart and lungs. For this purpose a rectal tube should be passed, a turpentine enema given containing turpentine 1 fl. oz. (30 ml.) in 15 fl. oz. (450 ml.) of starch mucilage, or turpentine stupes applied to the abdomen, prepared by sprinkling 60 m. (4 ml.) of turpentine over a hot fomentation. If these measures fail, a hypodermic injection should be given of 1 ml. of Pituitrin. For delirium and restlessness an ice compress should be applied to the head, and a rectal injection given of pot. brom. 120 gr. (8 G.) in water 2 fl. oz. (60 ml.).

During convalescence breathing exercises must be carried out to expand the lungs. These should be inspiratory in nature; and not expiratory as in blowing through Wolff's bottles. By this means the

risk of subsequent bronchiectasis is much diminished. Resolution should be checked by X-ray examination.

Hæmolytic Streptococcal Pneumonia. The hæmolytic streptococci are very sensitive to penicillin, which should be given in large doses, such as 1 million units (600 mg.) of benzylpenicillin 2 or 3 times in the 24 hours for 10 days.

Staphylococcal Pneumonia. Cloxacillin sodium (Orbenin) 250 mg. caps. should be given by mouth, two capsules six-hourly for 5 to 6 days.

For children Orbenin Syrup may be given, 125 mg./5 ml., 4 teaspoonfuls six-hourly for a week.

Friedländer Pneumonia. Streptomycin sulphate should be injected intramuscularly, first 1 G. every 8 hours for 24 hours, this is reduced to 1 G. every 12 hours for 48 hours, and then to 1 G. daily until the temperature has been normal for a week. Sulphadimidine should be simultaneously administered by mouth, an initial dose of 2 G., then 1 G. every 6 hours for a week, and then 1 G. t.i.d. for 2 or 3 weeks.

Other Bacterial Pneumonias

These include infections by *H. influenza*, *B. anthracis*, *P. tularensis*, *P. pestis*, *Mycobacterium tuberculosis*, *H. pertussis* and *Salmonella typhi*.

H. influenza is sensitive to streptomycin, which may be used in combination with sulphadimidine.

Bronchopneumonia in Infants

(Capillary bronchitis)

Etiology. This is a disease of infants and young children, due to a mixed infection of the terminal bronchioles with such organisms as the *H. influenza*, the staphylococcus, *Klebsiella pneumoniae* (Friedländer's bacillus), the pneumococcus and the streptococcus. It may also occur as a complication of such diseases as measles and whooping-cough.

Clinical Findings. The patient is usually an infant or young child. The onset is comparatively sudden, with the symptoms of a febrile cold.

On Examination : Inspection : The child looks flushed or cyanosed, restless and ill. The respirations are rapid, expiration grunting and a dry cough may be heard. The *alæ nasi* muscles are seen to be in action, and there may be recession of the intercostal spaces and retraction of the xiphoid process with inspiration. **Palpation :** Rhonchal fremitus may be felt, if there is an associated large-tube bronchitis. **Percussion :** Small areas of impaired resonance may be detected, especially in the lower lobes behind. **Auscultation :** The air entry is often weak over the lower lobes and harsh over the upper lobes. Small patches of bronchial breathing may be heard, with bronchophony and a few fine crepitations. Often, however, no sign of consolidation can be detected, but râles may be heard over the lower lobes. In confluent bronchopneumonia larger areas of consolidation are present. The heart sounds are rapid, and the pulmonary

second sound is usually accentuated. The temperature rises rapidly to 103° or 105° F. (39.4° or 40.5° C.), and then becomes remittent in type, falling by crisis or lysis in about 7 to 10 days. A further rise in temperature may indicate a fresh spread of the infection. The respirations may rise to 40 or 60 or even higher in a severe case, and the pulse rate to 120 or more. Infants have no sputum, any pulmonary secretion which is brought up on coughing being either swallowed or vomited. In severe cases the child is very drowsy, being overwhelmed with the toxæmia.

Differential Diagnosis. There is usually little difficulty in the diagnosis, but the extreme dyspnoea may suggest laryngeal diphtheria. There is, however, no obstruction to the airway through the larynx. In some cases the cerebral symptoms may suggest meningitis. Tuberculous bronchopneumonia is not often diagnosed in a child before death, although the course tends to be more prolonged and tubercle bacilli may be found in the faeces, from swallowed sputum.

Treatment. If the patient is an infant he must be in bed, but should be taken in the arms from time to time, to change his position. The shoulders and head should be slightly raised. The temperature of the room should be kept at 65° F. (18.3° C.) day and night, and the air moistened with a steam kettle, especially in cases of obstructive dyspnoea. If the temperature rises over 105° F. (40.5° C.), or there is much restlessness, the infant should be tepid sponged with water at 85° to 92° F. (29.4° to 33.3° C.). The diet consists of 6 to 8 fl. oz. (180 to 240 ml.) of equal parts of milk and water, containing 2 teaspoonfuls (8 G.) of lactose, every 3 hours. This is given by a spoon or by bottle. If there is curd indigestion, the feeds are citrated, using sod. citrat. 2 gr. (0.12 G.) to each fl. oz. (30 ml.) of undiluted milk. Drinks of half strength normal saline (0.42% sod. chlorid.) are given between feeds, and if the infant is dehydrated a continuous subcutaneous drip of normal saline is also advisable. The bowels should be opened every 2 or 3 days by syrup. flicorum 60 m. (4 ml.) nocte, or a glycerin suppository may be used. Cyanosis should be relieved by the use of an oxygen tent. Tetracycline (Achromycin), the elixir (B.N.F.) contains 125 mg./5 ml., may be given by mouth, the total daily dose according to weight being 12.5 mg./kg. Alternatively, for a severely ill child, aged 1 year, 300,000 units of a procaine penicillin may be injected every 12 hours. For circulatory failure, nikethamide (Coramine) 0.5 ml. should be injected subcutaneously every 4 hours. For restlessness and insomnia brandy 20 m. (1.2 ml.) in $\frac{1}{2}$ fl. oz. (15 ml.) of water may be given and repeated in 4 hours if necessary.

The Viral and Rickettsial Pneumonias

Virus infections causing pneumonic changes in the lungs include those due to measles, small-pox, influenza and psittacosis. Primary atypical pneumonia is thought to be due to a virus which has not yet been discovered. Rickettsial pneumonia is exemplified by Q fever.

Primary Atypical Pneumonia

(*Virus pneumonia. Virus pneumonitis*)

Definition. An acute catarrhal condition of the lungs, usually benign in character, probably caused by a virus, and characterised radiologically by soft shadows in the lungs, localised to one or more broncho-pulmonary segments.

Etiology. The virus has not been isolated. A non-hæmolytic streptococcus M.G. has been obtained from the lungs, and specific antibodies have been found in the blood of about 50% of patients during convalescence. It has not been transmitted to animals, but human volunteers have been infected by spraying the nose and throat with a bacterium-free filtrate, obtained from throat washings and sputum of patients suffering from the disease.

Pathology. The affected alveoli are filled with coagulated serum. There are localised areas of pulmonary collapse. The primary lesion is thought to be a peri-bronchitis and peri-bronchiolitis. Encephalitis is found in some cases.

Clinical Findings. The disease often occurs in small epidemics. The incubation period varies from 2 to 21 days, or longer. Frequently there are no catarrhal signs at the onset, but there may be a dry, racking cough, with headache and limb pains. Some cases are apyrexial, but the temperature usually rises to 100° F. or 103° F. (37·8° or 39·4° C.), and after remaining raised for 5 to 10 days, falls to normal by lysis. The sputum is mucoid, never "rusty" or "prune juice" in colour, but small hæmoptyses, of a teaspoonful or so, may be met with. It contains no characteristic or predominating organisms. The physical signs in the lungs are variable, small areas of collapse, indicated by *slight dulness and weak air entry, may appear from day to day*. The most characteristic sign is the presence of showers of râles, heard after cough, over the affected areas. The pulse rate is often slower than would be expected from the temperature. In severe cases there is cyanosis and marked prostration. The white cell count is usually normal, but there may be a slight leucopenia. Rarely an acute hæmolytic anæmia occurs, with slight jaundice and hæmoglobinuria. The sedimentation rate of the red cells is increased to between 20 and 40 mm. (Westergren) at one hour. The blood Wassermann reaction may be positive for a short time during the acute phase of the illness, and cold agglutinins are often found in the serum in high titre from the second to fourth weeks of the illness, using varying dilutions of the patient's serum and a washed suspension of group O human erythrocytes. The radiological findings are often more extensive than would be expected from clinical examination of the chest. There may be patchy opacities, somewhat resembling those seen in bronchopneumonia. They are often irregular in shape and vague in outline, with a hazy, ground-glass appearance. Over 80% of the lesions are situated at the base, and owing to areas of atelectasis, the diaphragm may be raised on the affected side. In other cases the lesion is apical, or a lateral film may show the shadows situated in the apex of the lower lobe.

Course and Complications. In the average case the temperature falls to normal in 7 to 10 days, but secondary rises of temperature sometimes occur. Complications include dry pleurisy, encephalitis, venous thrombosis in the legs, polyarthritis, fractured ribs from coughing and rarely a pleural effusion. An acute hæmolytic anæmia and hæmoglobinuria may be due to the cold agglutinins.

Differential Diagnosis. Apical lesions may be mistaken for pulmonary tuberculosis, or bronchial carcinoma. An area of basal bronchiectasis, with surrounding pneumonitis, may give rise to difficulty. The absence of early catarrhal symptoms is opposed to a diagnosis of influenza or tracheobronchitis. Failure to respond to penicillin usually excludes the diagnosis of lobar pneumonia. At times a prolonged fever, with a relatively slow pulse rate and low white cell count, suggest the diagnosis of typhoid fever. In some cases it may be necessary to exclude pneumonic consolidation due to psittacosis, Rickettsia infections such as the Q fever of Australia, American Q fever, and ornithosis.

Prognosis. Antibiotic treatment has shortened the duration of the illness. Recovery is the rule, but the X-ray shadows may not disappear for some weeks after convalescence is firmly established. The mortality rate is about 0.2%, and encephalitis is a dread complication.

Treatment. The patient should be kept in bed until the temperature has been normal for a week, and he should not return to work until the sedimentation rate of the red cells is normal, and the X-ray shadows have disappeared. Tetracycline (Achromycin) should be administered by mouth, in doses of 500 mg. every 6 hours for 5 to 7 days. A dramatic response is often obtained. Vitamin B should be given as Beplex capsules 2, t.d.s. Steam inhalations may relieve the distressing cough. For severe cyanosis and dyspnœa, oxygen should be administered by nasal catheter or a mask.

Pneumocystis Pneumonia

This is thought to be due to the *Pneumocystis carinii*. It is met with in debilitated infants, less often in adults who have received long-term corticosteroid treatment. Small translucencies are seen in X-ray films of the lung. The cyanosis and dyspnœa are out of proportion to the physical signs. It has been described in children as an interstitial plasma-cell pneumonia.

Pneumonitis

There is a localised area of inflammatory exudation in the lungs. This may be due to : 1. Chemical irritants. These include irritant gases such as ammonia, phosgene and mustard gas. Manganese pneumonitis may occur in men employed in the manufacture of potassium permanganate, and beryllium pneumonitis in fluorescent bulb workers. 2. Deep X-ray treatment. Excessive irradiation, as in the treatment of carcinoma of the breast, may cause pneumonitis and later fibrosis of the lung. This may be very severe, causing intense dyspnœa and mediastinal displacement. 3. Inhalation of oil. Lipid pneumonitis is due

to droplets of mineral or cod-liver oil, especially when forcibly administered to debilitated infants. It may also result from the use of nose drops containing mineral oil, or from taking liquid paraffin at night in patients suffering from dysphagia or even from constipation. Paraffin should never be taken at night.

Pulmonary Alveolar Proteinosis

This condition, which was first described in 1958, is characterised by distention of groups of alveoli with a finely granular eosinophilic protein-like material. This gives rise to diffuse areas of consolidation. The cause is unknown. The disease is more common in men than in women, and in adults than in children. The chief symptom is progressive shortness of breath. The physical signs are not marked, a few scattered râles may be heard. The X-ray film of the chest shows diffuse perihilar shadows, but no enlargement of root lymph nodes. The shadows may extend out to the periphery. Cases are liable to be mistaken for pulmonary oedema, sarcoidosis, pneumokoniosis and viral or fungal lung infections. Diagnosis can only be established by lung biopsy. The prognosis is uncertain but death from respiratory failure is liable to occur during the course of a few years. No effective treatment has been discovered.

Aspiration Lung Infections

Under this heading are included patchy areas of consolidation which may result from inhalation of septic material from the naso-pharynx. They may therefore be secondary to infections in the nose and throat, to inhalation of vomit or of a foreign body. Septic material may be coughed from the diseased to the healthy lung, as in bronchiectasis. In chronic bronchitis, infected mucus may block a bronchus and cause an area of collapse with high temperature, the condition rapidly clearing when the mucus is expectorated. This is not uncommon in children. Aspiration pneumonia is also met with in association with bronchial carcinoma. In the more severe forms of aspiration pneumonia localised areas of suppuration form, which may give rise to chronic lung abscess.

Pulmonary Tuberculosis

Definition. Tuberculous infection of the lungs, bronchi, bronchial lymph nodes or pleura.

Etiology. Pulmonary tuberculosis is caused by the *Mycobacterium tuberculosis*. Both human and bovine types affect man. Anonymous bacilli are described, the cultures of which turn greenish-gold on exposure to light. These bacilli are often resistant to anti-tuberculous drugs. The organisms may infect the body from dust or dried sputum, by droplet infection, or by contaminated articles of food, such as milk, cream, butter, cheese or meat. Contact with "open" or sputum-positive cases is probably the most important source of infection. The incidence of tuberculous infection can be determined by the Mantoux test (see p. 167), by which it has been shown that infection from birth to 5 years is five times greater in children who are contacts with sputum-

positive cases, than in those who are non-contacts. Further, between the ages of 0 to 15 years contacts are infected twice as often as non-contacts. Close contact with "open" cases of pulmonary tuberculosis, as in households or at work, is a very important cause of active tuberculosis in adults. Conjugal infection is a very real danger which has been underestimated in the past. *Predisposing causes:* 1. Heredity. The disease undoubtedly occurs in families, and in some rare instances infants may be born with tuberculosis. 2. Race: Virgin races are very susceptible, i.e. those which have not previously suffered from the disease, and which, as the result of civilisation, are brought in contact with it. 3. Sex: There is a slight predominance of males. 4. Age: It is comparatively uncommon between the ages of 5 and 15 years. Infants under the age of 5 may be infected from an "open" case. The adult type of disease occurs chiefly after the age of 21, and often later in men than in women. It may be met with in geriatric institutions. 5. Climate: Pulmonary tuberculosis is prevalent in districts exposed to rain-bearing winds. 6. Sanitation: Overcrowding and absence of sunlight and fresh air are potent predisposing factors. 7. Occupation: Inhalation of dust, especially silica particles. Tin miners are prone to the disease, whereas coal miners are relatively immune. 8. General health: Lack of food, overwork, chronic alcoholism, diabetes mellitus and measles predispose to tuberculosis.

Pathology. The tubercle bacilli may reach the lungs by three routes: By the respiratory tract, by the blood stream and by lymphatics. In childhood, infection is chiefly from the alimentary tract, due to infected milk. The organisms are of the bovine type, and pass by lymphatics to the bronchial lymph nodes and thence to the lungs. The bacilli may also travel from the tonsils to the cervical lymph nodes and thus to the lungs. Pathologically there are two types of pulmonary tuberculosis, exudative and productive. Exudative changes occur when tubercle bacilli reach the alveoli. The alveoli are filled with an exudate containing mononuclear cells, and the condition is tuberculous pneumonia. In productive tuberculosis granulation tissue forms, which constitutes the tubercle. This may disappear or it may caseate and form a cavity. The solid solitary lesion, seen on X-ray films, known as a "coin" shadow or tuberculoma, is due to liquid or caseous material in a cavity whose bronchus has become blocked.

Dissemination of tubercle bacilli from a caseous focus in the lungs may be bronchogenic, hæmatogenous or lymphatic. Bronchogenic spread leads to lesions in the same or opposite lung, hæmatogenous dissemination to tuberculosis in distant organs such as the bones, kidneys, joints, or to miliary tuberculosis, and lymphatic spread results in tuberculous lesions in the root and supraclavicular lymph nodes.

Types of Pulmonary Tuberculosis. *Primary pulmonary tuberculosis in children.* The primary focus is small. It may occur in any part of the lungs, often in a lower lobe, and it constitutes the Ghon's focus. The corresponding hilar lymph nodes are rapidly infected and enlarge. These two lesions constitute the *primary complex*. They caseate and heal by calcification. The root lesion is larger than the primary focus. The

infected bronchial lymph nodes may compress a bronchus and cause epituberculosis. This is either tuberculous pneumonia or atelectasis of a pulmonary segment.

Less often healing does not occur and a *progressive primary complex* develops which may be fatal. The changes produced in the lungs resemble those in adult tuberculosis, and bronchogenic or hæmatogenous spread may occur.

Primary pulmonary tuberculosis in adults. When a Mantoux negative young adult, such as a medical student or nurse, is found to have become Mantoux positive, what is known as Mantoux conversion has taken place. This means that he has developed a tuberculous lesion, usually in the lungs, as the result of contact infection at his work. Often the individual does not feel ill and no X-ray changes are seen. In other cases, months later, a small focus is seen nearly at the apex of a lung (Assmann's focus). This may be progressive and lead to cavitation, but usually it heals by fibrosis, and not by calcification, as does the primary infection in children. The reason for this is not known.

Re-infection pulmonary tuberculosis in adults. This may be due to a reactivation of a childhood infection in the lungs or elsewhere, but more often it results from a recent infection by inhalation from contact with a person suffering from pulmonary tuberculosis. In childhood infections the organism is almost always of the bovine variety, in adult tuberculosis the organism in the vast majority of cases is of the human type.

Pathologically there is a blending of exudative and productive lesions. Caseation and cavitation occur, localised healing and localised extension take place simultaneously, and fibrotic changes ensue, but there is little tendency to calcification. Clinically this type of tuberculosis includes the majority of cases met with in young people and adults, but many cases we see in adult life are first infections, no childhood infection having taken place. Bronchogenic spread is common, hæmatogenous spread is rare, and the root lymph nodes are seldom enlarged.

Tracheobronchial tuberculosis. It was only with the more extensive use of bronchoscopy in pulmonary tuberculosis that bronchial tuberculosis was recognised. It is important as it may cause ulcerative lesions in the larger bronchi with subsequent stenosis, which prevents the closure of lung cavities, and necessitates pulmonary resection.

Clinical Findings. Pulmonary tuberculosis may have an insidious or acute onset. The former is the more common. *The insidious onset:* Mass miniature radiography has shown that the initial lesion is often symptomless. The early symptoms are very numerous; amongst the most important are the following: Cough, which persists for several months, usually with expectoration. Lassitude and loss of weight. Palpitations or dyspnoea on exertion. Nervous debility which may simulate neurasthenia. Amenorrhœa is not infrequent. In other cases hoarseness is the earliest symptom. Some patients complain of periodical shivering or sweating. The symptoms may date back to what the patient designates an attack of influenza, or to a cold which has never properly disappeared. In children an attack of measles or whooping-

cough may be followed by persistent ill-health leading up to the diagnosis of tuberculosis. *The acute onset* : This may also be of several varieties. *Hæmoptysis* : The patient is apparently in good health and suddenly coughs up blood, in varying amounts. *Spontaneous pneumothorax* : Here also the patient is apparently well, when the pneumothorax suddenly occurs with severe pain and dyspnoea. *Pleurisy* : This may be acute dry pleurisy or pleurisy with effusion. *Acute influenzal type*. *Acute pneumonic or bronchopneumonic tuberculosis* ("galloping" consumption) : The onset closely resembles that of lobar or bronchopneumonia. *Acute military tuberculosis* : The patient is suddenly taken ill with a high fever, malaise and dyspnoea. This is more common in children than in adults.

On Examination : 1. *Chronic pulmonary tuberculosis* : The early stages. There is no characteristic appearance, and the patient is not usually wasted, although the weight is often below his highest known weight. *Examination of the chest*. *Inspection* : There may be drooping of one shoulder, with slight flattening and diminished expansion of the upper part of the chest on the affected side. *Palpation* : Tactile fremitus is slightly increased over this area. *Percussion* : The note is slightly impaired at the upper part of the chest, and Krönig's area of apical resonance above the clavicle may be diminished. *Auscultation* : The breath sounds over the affected area of lung may be weak, expiration may be prolonged, or the air entry jerky. The breath sounds in other cases are broncho-vesicular or vesiculo-bronchial. At the back the breath sounds in the supraspinous region may be coarse and rough (Grancher's "granular" breathing). The air entry may be weaker at the base on the affected side. Often there are no adventitious sounds, or an occasional râle may be heard after cough. There is usually slight bronchophony and faint pectoriloquy. The special signs and symptoms indicative of activity are described below.

Consolidation of the Lung : The signs in the chest are more marked. The note is dull, tactile fremitus is increased, the breath sounds are bronchial, usually some coarse râles are heard, and there is bronchophony and pectoriloquy.

Caseation of the Lung : There is dulness with increased tactile fremitus ; the breath sounds are hollow and bronchial, and after cough, showers of crackling and bubbling râles are heard. There is also bronchophony and pectoriloquy.

Excavation of the Lung : There is flattening of the chest wall over the cavity ; the note is hyperresonant over the cavity if it contains air, and if it is in communication with a bronchus a "cracked pot" sound may be heard on percussion (*bruit de pot fêlé*). The breath sounds are amphoric or cavernous, and coarse or metallic râles are heard. There is intense bronchophony and pectoriloquy, and immediately after cough a hissing sound may be heard (post-tussive suction). When a large cavity contains air and fluid a coin sound and ægophony may be present. If the cavity is filled with fluid the physical signs are dulness, weak breath sounds and diminished voice conduction.

Fibrosis of the Lung : There is flattening of the chest wall, with

diminished tactile fremitus, dullness, weak air entry and coarse leathery or sticky râles. Vocal resonance is diminished. If the fibrosis affects the left upper lobe, pulsation may be seen in the second and third left spaces close to the sternum, caused by retraction of the lung and uncovering of the heart. The trachea may be displaced to one or other side, and this may occur without any cardiac displacement, if the fibrosis affects the upper part of the mediastinum only.

Various lesions are often combined in chronic pulmonary tuberculosis, such as caseation or consolidation with fibrosis.

2. *Chronic miliary tuberculosis*: The patient is usually between the ages of 11 and 30 years and may complain of cough, dyspnoea, pain in the chest, expectoration, and at times of hæmoptysis. The evening temperature is usually a little raised. The signs in the lungs are very slight, a few scattered râles being heard at several points. The spleen may be palpable, and lymph nodes, bones or joints may show tuberculous lesions. Diagnosis can be established in many cases by finding tubercle bacilli in the sputum, stomach washings, or in a pleural effusion if it is present. X-ray examination shows small, rather soft, nodular shadows, scattered throughout the lung fields. These were formerly diagnosed radiologically as being due to acute miliary tuberculosis. The patient, however, is often ambulant and not very ill, the course of the disease may be prolonged for a year or more, and arrest may occur. The differential diagnosis includes other causes of miliary or submiliary infiltration of the lungs, as seen on X-ray examination, such as carcinomatosis, pneumoconiosis, sarcoidosis, bronchiolitis, leukæmia, kala-azar, polyarteritis nodosa, the rheumatoid lung, the lung in scleroderma, bacillary dysentery, bilharziasis, streptococcal infiltration, silicosis, actinomycosis, xanthomatosis, pulmonary hæmosiderosis associated with mitral stenosis, and tropical eosinophilia with pulmonary shadows (Weingarten's disease) and Löeffler's syndrome which is met with in children.

General Examination: The fingers are often clubbed, in the early stages the nails being curved like a parrot's beak or puffin's bill. Drum-stick clubbing is more often associated with bronchiectasis. The cheeks, ears and lips may show slight degrees of cyanosis. The temperature is usually raised, if there is activity present, as described later, and the pulse is also quickened. The sputum: This possesses no characteristic appearance. It may be thin and frothy, or thick and purulent. In advanced cases it is often green and nummular, floating on water in flat circular masses about the size of a shilling. Blood may be present in streaks or clots, or the sputum may be uniformly coloured pink. An examination for tubercle bacilli should be made on several occasions in every doubtful case, but negative results do not exclude a diagnosis of tuberculosis. The sputum may also be cultivated for tubercle bacilli. In the case of children or patients with no sputum a few droplets of mucus may be coughed up and collected upon a laryngeal mirror or swab held at the back of the throat. At times tubercle bacilli may thus be found. The blood: There are again no characteristic changes. The rate of sedimentation of the red cells in citrated blood is an indication

of activity in tuberculosis, and a guide to progress, but it is not a diagnostic test of tuberculosis. Tuberculin tests are only indicative of a tuberculous infection at some time in the life of the patient, and not of present activity.

X-ray Examination: This should form part of the routine examination of every suspected case of pulmonary tuberculosis, although tuberculosis cannot in every case be diagnosed solely on a film. Deep seated cavitation can best be revealed by tomography.

3. *Acute influenzal type*: Attention has been drawn to the acute form of onset resembling influenza, in which the patient is not nearly so ill as in the bronchopneumonic variety.

On Examination: Some râles are heard below the clavicle in the second and third spaces, and the X-ray films show infiltration usually in the upper zone below the clavicle, less often in the middle or lower zone.

4. *Acute pneumonic tuberculosis*: The mode of onset resembles that of lobar or lobular pneumonia, but in some cases it is not quite so sudden. In children, acute tuberculosis often follows an attack of measles or whooping-cough, whereas in adults there has usually been a pulmonary tuberculous focus for some time, as shown by fibrosis with mediastinal displacement.

On Examination: Signs of consolidation are generally found in the lower lobe of one lung. The temperature is raised to 101° or 103° F. (38.3° or 39.4° C.), and remains continuously so for a week or ten days. A crisis does not occur, but the temperature begins to swing more, becoming remittent in type, and the signs of toxæmia are more evident. The cyanosis of a mauve tint is very characteristic, with tachycardia and dyspnoea. The physical signs become more those of caseation than of consolidation. The diagnosis is established by finding the tubercle bacilli in the sputum.

5. *Acute miliary tuberculosis*: In addition to the symptoms mentioned on p. 165, examination of the chest may reveal remarkably few abnormal signs, or there may be râles scattered through the lungs. Drenching night sweats are often a marked symptom, but there are usually no rigors. The temperature is of the remittent or intermittent type, and it may be inverted, the morning temperature being higher than the evening. X-ray examination shows changes closely resembling those found in chronic miliary tuberculosis (see p. 165) and both lungs may present a "snow-storm" appearance. The patient rapidly becomes more ill, the spleen may be palpable, and death usually occurs from profound toxæmia in 2 weeks to 3 months.

The following are the signs indicative of active disease. The temperature: A rise of mouth temperature, to 99° F. (37.2° C.) or over, usually in the afternoon or evening. This may occur when the patient is at rest, or only after exercise. In some cases activity may be present when the temperature does not rise above normal, a subnormal swing being found. The pulse: Persistent rapidity at rest is usually an indication of activity. The sputum: The presence of tubercle bacilli. X-ray evidence of cavitation or of spread of the disease. Other indica-

tions of active disease are an increased rate of sedimentation of the red cells, loss of weight, increase of cough and expectoration, night sweats, and lassitude.

Differential Diagnosis. The chief difficulty arises in the diagnosis of the early case. Great attention should be paid to the various symptoms detailed on p. 165. A temperature record should be obtained with the patient in bed, and, if he is afebrile, the effect on the temperature of the patient getting up and exercising should be determined. The lungs must be X-rayed, and special knowledge is required for the correct interpretation of the films. The X-rays may reveal a shadow due to infiltration of the lung parenchyma, but this infiltration may be due to causes other than tuberculosis. In *sarcoidosis* (Besnier-Boeck-Schaumann disease) a diffuse mottling of the lung fields may be seen on X-ray examination, resembling miliary tuberculosis (see p. 165). The sputum should be examined repeatedly for tubercle bacilli by direct films, culture and guinea-pig inoculation, and if not found the stomach washings and faeces should also be tested. Other causes of ill-health which especially require exclusion are tachycardia and loss of weight due to hyperthyroidism and pyrexia due to septic foci elsewhere. The Mantoux intradermal tuberculin test can be applied. A positive reaction only implies that the patient has been infected with tuberculosis at some period of his life, not that he has active disease now. A negative reaction, on the other hand, is strong evidence against the diagnosis of active pulmonary tuberculosis. It is performed by injecting into the skin of the forearm, between the dermis and epidermis, 0.1 ml. of old tuberculin (O.T.) or of Purified Protein Derivative (P.P.D.) diluted to 1/10,000. A tuberculin syringe should be used. The arm is observed 48 hours later, and a positive reaction consists of a central zone of oedema, not less than 5 mm. in diameter, surrounded by a zone of erythema. If the test is negative it is repeated 24 hours later, using now 0.1 ml. of 1/1,000 O.T. If this test is negative a third test is made with 0.1 ml. of 1/100 O.T. The Heaf multiple puncture test is easier to perform. Using a Heaf gun six needles are fired through the end plate which is perforated with six holes. The end plate is placed on the skin over a film of special glycerinated P.P.D. The needles stab the skin through the tuberculin film to a depth of 2 mm. The result is read in 5 to 7 days. The Vollmer's patch test and the tuberculin jelly patch test are alternative methods of applying the tuberculin test but are probably not so reliable. When there are definite signs in the lungs, such conditions as bronchitis and emphysema, a new growth, actinomycosis, and pulmonary fibrosis due to other causes, such as syphilis or pneumoconiosis, must all be differentiated from tuberculosis. The difficulty is increased by the fact that pulmonary tuberculosis may coexist with any of these conditions.

Course and Complications. *Acute caseous tuberculosis*: This usually rapidly extends and may prove fatal in 2 to 3 months; arrest, however, does occur in a certain proportion of cases. *Acute miliary tuberculosis*: This is often fatal in 2 weeks to 3 months. *Chronic pulmonary tuberculosis*: A very variable course must be expected, depending largely

on the resistance of the patient and the response to treatment. Thus an early lesion may be almost immediately arrested, or it may gradually extend. Periods of activity may alternate with times of comparative arrest.

The following complications are of great importance : Endobronchial tuberculosis : This results in bronchial stenosis, and is discovered by bronchoscopy. The bronchi may become infected by direct infiltration from the lungs, from infected sputum, by infection caused by the blood or lymph, or as part of the primary infection. It may give rise to areas of pulmonary collapse, to obstructive emphysema, to tension cavities, or to bronchiectasis. If the larger bronchi are affected there may be localised wheezing. A positive sputum with no evidence of active disease is always suggestive of endobronchial tuberculosis. Laryngitis, catarrhal or tuberculous. Pleurisy, dry or with effusion. Pneumothorax. Intestinal tuberculosis. This results from swallowing sputum containing tubercle bacilli. The lesion is usually in the ileo-cæcal region. If it is so, X-ray examination shows that the barium does not fill the cæcum when the ileum, ascending and transverse colons are filled. Anal fistula. Meningitis. Bronchitis and emphysema. Spontaneous subcutaneous emphysema rarely occurs. Asthma. Bronchiectasis. Tuberculosis of the epiglottis, tonsils, trachea, pharynx, tongue or nose. Tuberculosis of the epididymis, prostate, bladder, peritoneum or kidneys. Venous thrombosis. Peripheral neuritis. Amyloid degeneration. Rib abscess. Myocarditis and pericarditis.

Prognosis. This has been much improved by antimycobacterial treatment. Complications increase the gravity of the disease, especially diabetes mellitus and tuberculous enteritis. Meningitis is a very serious complication. Freedom from financial worry enables life to be passed under the most favourable conditions, and thus improves the prognosis. Further, the prognosis does not depend entirely upon the activity or extent of the disease, but the type of disease present is of the greatest importance. Thus bilateral disease with extensive fibrosis associated with thick walled cavities is always unfavourable. The prognosis is improved if the lesions heal by calcification.

Treatment. Prophylactic: Public health authorities are concerned with prophylaxis. Good housing and sanitation and a pure supply of milk are of first importance. Bovine tuberculosis in childhood could be completely eradicated if the milk supply were free from tubercle bacilli. This can be achieved in two ways, either by stamping out the disease from the dairy herds or by killing the tubercle bacilli in infected milk by pasteurisation. In order to stamp out, in addition to tuberculosis, brucella and other infections conveyed by milk, the only safe way is by universal pasteurisation. Isolation of all open cases would probably prove an effective means of stamping out the disease caused by human tubercle bacilli, but this is not possible. Unsuspected cases of "open" pulmonary tuberculosis in the general wards of a hospital, especially in surgical wards, are a source of danger to nurses and students. All patients admitted to hospital should have a chest examination by miniature radiography as soon after admission as possible. No nurse

who is Mantoux negative should look after patients suffering from pulmonary tuberculosis. Strict precautions should be taken to protect nurses from infection. Nurses must wear masks and gowns when carrying out any nursing treatment. Patients must wear a mask while the chest is being examined. The sputum should be collected in a glass jar or a polythene sputum flask containing 2 fl. oz. (60 ml.) of Miltherex. This liquefies the sputum and kills the tubercle bacilli.

Prophylactic inoculation of infants with vaccines made from attenuated living bovine bacilli, such as the B.C.G. (*bacille-bilié* Calmette-Guérin), is practised extensively. In Sweden 90% of all infants have B.C.G. during the first week of life. B.C.G. is used for vaccination of Mantoux-negative medical students and members of hospital staffs, and for children born of tuberculous parents. The Danish vaccine must be used within 14 days of its preparation. It must be shaken well before use, and 0.1 ml. of the vaccine containing 0.5 mg. per ml. is injected strictly intradermally using a tuberculin syringe fitted with a Luer needle, No. 25 or 26 (B.W.G.). The skin of the forearm is used and a weal about 5 mm. in diameter is produced. About 2 weeks later a painless papule forms which increases in size up to about 20 mm. in diameter by 6 weeks. The papule may form a small ulcer. It takes about a year to disappear. Local ulceration, abscess formation or regional lymphatic adenitis may occur as unwelcome complications. The multiple puncture method, using the Heaf multiple puncture pressure gun, with needles adjusted to 1 mm. penetration, and a freeze-dried vaccine has been found to give good results with freedom from complications. Alternatively 0.1 ml. of freeze-dried B.C.G. vaccine (Glaxo) containing between 4×10^6 and 9×10^6 viable bacilli per ml. can be given as a one shot from a Dermo-jet injector. The Mantoux test is repeated in 6 to 8 weeks and should be positive to 1/100 O.T. Open cases of tuberculosis in contact with children constitute a grave source of danger.

Mass miniature radiography used for selected groups of adults, such as factory workers and those in the Services, has revealed an incidence of about 4 per 1,000 unsuspected cases of pulmonary tuberculosis. In all such cases investigations should be carried out to determine whether or not the disease is active.

Curative: The patient should be put to bed, and kept there until the temperature is normal. He is then gradually allowed up, first for toilet purposes, then for $\frac{1}{2}$ hour daily, and the time up is gradually increased until he is up 8 hours a day or longer, and is considered fit to begin part-time work.

Antimycobacterial drugs. The antimycobacterial drugs used in the treatment of tuberculosis are streptomycin, isoniazid, and para-aminosalicylic acid. None of these should be given alone owing to the risk of the rapid appearance of drug-resistant bacilli in the sputum. In untreated cases about 5% of tubercle bacilli in the sputum are resistant to one of the drugs.

Streptomycin. This has a bacteriostatic action. It is injected intramuscularly in the form of streptomycin sulphate. In a severe case

1 G. should be given daily for 4 to 8 weeks, followed by 1 G. 2 or 3 times a week. In less severe cases it is given 2 or 3 times a week from the onset of the treatment. With these doses there is little risk of labyrinthine disturbances or of deafness.

Isoniazid (Isonicotinic acid hydrazide. I.N.A.H.). This is given by mouth as a tablet in doses of 100 mg. 2 or 3 times daily, according to the weight of the patient, combined with streptomycin or with P.A.S. The combined treatment should be continued for at least a year after the last positive sputum culture, after the last X-ray indicative of improvement, and after the last cavity has closed. This usually means 18 months' to 2 years' treatment.

Para-aminosalicylic acid (P.A.S.). This is given as the sodium salt immediately after food. The patient is not usually able to take more than 12 G. in the 24 hours as it is very liable to produce gastro-intestinal disturbances. It can be given as Paramisan sodium 1.5 G. cachet.

Reactions to I.N.A.H. include a rise of temperature, a pustular rash, peripheral neuritis, enlarged lymph nodes, optic neuritis and atrophy, and psychoses. Intolerance to P.A.S. is shown by gastro-intestinal disturbance, a rise of temperature and a rash.

I.N.A.H. and P.A.S. may be given together instead of using streptomycin, as Pasinah 25 cachet, each containing Sod. P.A.S. 1.5 G. and I.N.A.H. 25 mg. Two cachets q.i.d. p.c., but it is usual to ring the changes on a combination of two out of the three drugs.

If the patient becomes resistant to streptomycin and I.N.A.H., *Viomycin* may be injected intramuscularly in doses of 1 G. morning and evening twice a week. The urine should be frequently examined for protein and casts, as renal failure may occur. *Viomycin* is often used when preparing a patient for an operation.

When the bacilli are sensitive to only one of the three standard drugs, Cycloserine 250 mg. tab. may also be given, one tablet a day for one week, two tablets daily for two weeks, and then three tablets daily. Watch should be kept for side-effects, headache, behaviour changes, psychotic episodes, convulsions, etc. The drug is best given in hospital.

In very acute cases of pulmonary tuberculosis prednisone, three 5 mg. tab. may be given q.i.d. for a few days and then gradually reduced to one tab. t.i.d. for 1 to 2 months.

Artificial pneumothorax. This is seldom used, but it is of value in some cases, combined with antimycobacterial drugs, to close a cavity and so to prevent or retard the appearance of drug-resistant bacilli.

Pneumoperitoneum. When effective this produces a reduction of up to 40% of lung volume. It is of value in bilateral cases.

Extrapleural compression. Plombage may be effected by the insertion of lucite balls extrapleurally, after the apex of the lung has been freed.

Thoracoplasty. This is of value to close cavities in long-standing disease, especially in older patients. It should be limited to 4 to 7 ribs, and done in three stages.

Pulmonary resection. After a full course of antimycobacterial treatment there may be residual localised solid or cavitated pulmonary

lesions, especially blocked cavities. These may be removed by segmental resection or by lobectomy. The patient should remain in bed for 4 to 6 months after the operation, to prevent relapse.

Treatment of Certain Complications. Night sweats are at times very distressing. The bed-clothes should be light and the windows kept well open at night. A pill containing Zn. oxid. 2 gr. (0.12 G.) and ext. belladon. sicc. $\frac{1}{4}$ gr. (15 mg.) at night should also be tried. Hæmoptysis: The treatment is considered on p. 193. Laryngitis: The patient should whisper in the early stage. He must not smoke. Streptomycin combined with I.N.A.H. is the most efficient treatment. If there is severe pain on swallowing, a powder composed of equal parts of benzocaine and orthocaine may be used. As much as will cover a sixpence is placed on the palm of the hand and inhaled directly into the larynx through a curved Leduc's glass tube, just before a meal. In other cases, when the pain prevents swallowing even liquids, relief may be obtained by using a glass tube, which dips into the milk which is placed on the floor, the patient sucking it up, with his head hanging over the edge of the bed. Firm pressure applied over both ears by the palms of the hands may also enable the patient to swallow in comparative comfort. If these measures fail, alcohol injection into the superior laryngeal nerve may give temporary relief. The dying patient may have his last days made comfortable with the help of the following medicine, Cocain. hydrochlor. $\frac{1}{2}$ gr. (10 mg.), morphin. hydrochlor. $\frac{1}{2}$ gr. (10 mg.), gin 60 m. (4 ml.), honey 60 m. (4 ml.), aquam dest. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s.

Sanatorium Treatment. The sanatorium must be properly equipped with a skilled staff, medical and surgical, and X-ray facilities. Many sanatoria are now closing down, because the results obtained in hospital or at home with antimycobacterial treatment are so satisfactory that they are no longer required.

The After-treatment. When arrest of the disease has been firmly established, the question of return to work and the suitability of the employment has to be decided. In general, all heavy muscular work should be avoided, and outdoor occupations are unsuitable unless the patient is protected from the extremes of climate and from getting wet. Indoor occupation is not harmful provided the environment is healthy and the patient can look after himself adequately at home. There remain a certain number of patients who do not do well with treatment. These are often sent back to their homes, eventually to die. They are "open" cases of tuberculosis and undoubtedly are a great risk to others. If all "open" cases of pulmonary tuberculosis were isolated the hope of stamping out this disease would be increased.

Emphysema

Definition. A condition characterised by enlargement of the air spaces distal to the terminal bronchiole accompanied by destructive changes.

Etiology. Emphysema may be inflammatory, degenerative, or

obstructive in origin. In chronic bronchitis the air may be trapped in the alveoli, owing to difficulty in returning through the partially obstructed bronchioles. In many cases of chronic bronchitis, however, there is no emphysema, and severe emphysema may develop with no bronchitis. Focal emphysema may occur in dust diseases, around deposits of dust. In "over-inflation" or dilatation emphysema the alveoli are enlarged without destruction of their walls. In *centrilobular emphysema* the respiratory bronchioles are primarily destroyed with emphysematous spaces near the centre of the lobules. The whole of the acinus is affected in *panlobular emphysema*.

There is no one cause for emphysema. It may result from:—
 (1) Obstruction to expiration due to changes within or without the bronchi. (2) Deformity of the chest owing to arthritis of the spine. (3) Stretching or degeneration of elastic and collagen fibres in the alveoli. (4) Over-inflation of lung tissue secondary to destruction of other parts of the lungs, as in tuberculosis, resection, etc.

Varieties. The following clinical varieties are recognised. Acute vesicular. Acute interstitial. Chronic generalised. Atrophic or senile. Chronic localised or dilatation.

Acute Vesicular Emphysema

Definition. Sudden over-distention of the pulmonary air vesicles which form blebs or bullæ.

Etiology. Acute vesicular emphysema is associated with severe coughing or muscular strain. It may be met with in whooping-cough, asthma or asphyxia. In children it may occur adjacent to a consolidated area of lung in bronchopneumonia and sometimes in women in prolonged labour, or in blast injuries of the chest.

Clinical Findings. The symptoms which might be associated with it are masked by those of the primary condition. Its presence can sometimes be detected radiologically by a ring shadow indicating a large bulla or pneumatocele.

Acute Interstitial Emphysema

Definition. A condition characterised by the presence of air in the interstitial tissues of the lungs, the air is derived from ruptured pulmonary alveoli. It differs therefore from pulmonary emphysema.

Etiology. The air vesicles may rupture with comparatively moderate muscular exertion, such as while playing a game of hockey. Other causes include a wound of the chest, fractured rib, or the severe paroxysms of cough in whooping-cough or bronchopneumonia. It occurs occasionally in pulmonary tuberculosis, apart from any effort.

Pathology. The escaped air tracks along the pulmonary roots and may reach the mediastinum, or appear as surgical or subcutaneous emphysema in the neck and chest. It may also pass into the pleural cavity or into the retroperitoneal tissues.

Clinical Findings. In cases occurring during exercise, the patient feels a tightness or pain in the neck and chest, and shortness of breath.

On Examination: The crackling signs of surgical emphysema may be felt on the chest or neck. If the air has extended into the anterior mediastinum the superficial cardiac dullness is obliterated, the heart sounds are distant, and crunching sounds may be heard over the præcorium as the patient breathes and the heart beats.

Course. The air is usually absorbed spontaneously in a few days.

Treatment. The patient is kept in bed. He usually prefers to be propped up. A hypodermic injection of morphin. sulph. $\frac{1}{8}$ gr. (10 mg.) will help to check cough and induce sleep. In severe cases relief of tension may be obtained by inserting a needle into the suprasternal tissues, or by underwater drainage of a tension pneumothorax.

Chronic Generalised Emphysema

(Diffuse Obstructive Emphysema)

Definition. A condition of generalised dilatation of the alveoli, with an insidious onset.

Etiology. Obstruction to the bronchioles is thought to be a more important cause of emphysema than is a constitutional weakness of the elastic tissues of the lungs. The obstruction acts as a ball valve, the air gets into the alveoli, but its passage out is impeded, and so alveolar dilatation occurs with weakness of elastic tissue. Other factors which are of importance include : 1. Excessive inspiratory efforts : In chronic bronchitis and asthma the inspiratory efforts are stronger than the expiratory, hence the lungs become over-distended. 2. Violent expiratory efforts : These may be associated with chronic cough. Clinically the chest wall is often unduly rigid in emphysema.

Pathology. Both lungs are affected. They are not hypertrophied, but stretched. At autopsy they are bulky, pale and soft, and lacking in elasticity. Bullæ may be seen on the surface, especially along the anterior borders. On section the lungs are pale and the dilated alveoli may be noticeable. They float in water. As the alveoli dilate, the dividing septa break down and bullæ form. Aeration of the blood is diminished in emphysema for the following reasons : The aerating surface is reduced owing to the loss of the septa. The lumen of the vessels is narrowed in the stretched alveolar walls, thrombosis occurs in the pulmonary arterioles, and so circulation is impeded. Some blood is short-circuited from the pulmonary arterioles to the bronchial venules. The right side of the heart dilates and the motor power of the pulmonary circulation is reduced.

Clinical Findings. The patient is usually a male, of middle age or over. He may give a history of winter cough. His chief complaint is shortness of breath on exertion. There may be headache, giddiness and loss of appetite.

On Examination: The patient may be cyanosed, slightly or to an extreme degree, and the fingers may be clubbed. The chest. Inspection :

The diameter is increased antero-posteriorly (barrel-shaped chest), the ribs run more transversely than normal, the subcostal angle is wide and there is kyphosis in the upper dorsal region. Post-mortem and X-ray examinations have shown that marked emphysema may occur without the presence of the "barrel-shaped syndrome" and *vice versa*. Expansion is poor, the movement on inspiration being chiefly one of elevation. Dilated venules may be seen along the line of the diaphragmatic attachment. Palpation: Tactile fremitus is diminished. The cardiac apex cannot be felt. Percussion: The note is hyperresonant generally. The areas of cardiac and hepatic dullness are reduced. Auscultation: The breath sounds are weak. Expiration may be prolonged; scattered rhonchi or râles may be heard. There is no bronchophony and no whispering pectoriloquy. The heart sounds usually have their maximum intensity over the xiphoid process. The patient is often unable to blow out a lighted candle. If the intrapleural pressure is taken it is often found to be raised. X-ray examination: The translucency of the lungs is increased, especially at the bases. The ribs run more transversely than normal. The diaphragm is low and shows diminished movement. The heart shadow is small, as the heart rotates to the right with the depression of the diaphragm. There is an increased air space in front and behind the heart. The sputum: This is scanty and rather frothy. The blood may show an excess of red cells.

Respiratory function tests. *The vital capacity.* In emphysema this volume may be reduced by 50% or more. Further, a normal person should be able to expel 95% of his vital capacity air in 3 seconds. In emphysema this time is prolonged. The volume of air expelled in 1 second (F.E.V.1) is reduced from about 80% to 40%. *The residual volume (R.V.)* and *the functional residual capacity (F.R.C.)* are increased. *The dead air space* may be doubled. *The resting diffusing capacity for O₂* is reduced. In the later stages there is a rise in the arterial pCO₂. *Spirograms.* These are tracings of respiration made on a recording revolving cylinder, the writing pen of which is connected with the spirometer, whose movements are thus registered. In emphysema, although the movements in normal respiration are normal, in forced expiration after a maximum inspiration there is delayed expulsion of air, so that the expiratory curve is broad and shallow.

Differential Diagnosis. The diagnosis of emphysema, which is often made with such certainty clinically, has been shaken by post-mortem observations in which no such condition has been found to exist.

Course and Complications. Emphysema tends to be progressive. Chronic bronchitis, asthma, dilatation of the right side of the heart, tricuspid regurgitation, a pulsating liver and other signs of heart failure are liable to occur (see Cor pulmonale, p. 239) with CO₂ narcosis. Other complications include pulmonary tuberculosis, spontaneous pneumothorax or acute interstitial emphysema, due to rupture of a bulla.

Prognosis. There is usually no immediate danger, apart from the presence of heart failure. The ultimate outlook is very grave. A raised pCO₂ is very unfavourable.

Treatment. *Prophylactic:* Occupations involving strain should be avoided by those predisposed to, or with early signs of emphysema.

Curative: There is no curative treatment. All that can be hoped is to decelerate the natural progress of the disease. If possible, the patient should winter in a milder climate abroad. If this is not feasible, every effort should be made to avoid bronchitis and bronchospasm, and if they occur they should be treated early and rigorously. Walking may be aided by means of a portable oxygen inhaler with a cylinder weighing 2 to 5 lb. (0.9 to 2.3 kg.). An emphysema elastic abdominal belt and expiratory breathing exercises, as for asthma, are of some value. Heart failure must be treated by rest, venesection, digitalis, and a low salt diet.

Administration of oxygen in severe cases of emphysema may be dangerous and cause death from carbon dioxide poisoning. The reason is as follows: In emphysema the arterial blood contains an excess of CO_2 , absorbed from the stagnating air in the alveoli. The respiratory centre, which is normally stimulated by CO_2 , eventually becomes insensitive to this stimulus, and the respiratory stimulation is now due to hypoxæmia. The lack of oxygen in the blood stimulates respiratory movements through the carotid bodies. If oxygen is now administered this stimulation to respiration is removed. Respiration fails, and a great excess of CO_2 accumulates in the arterial blood which proves fatal. Oxygen should therefore be administered with caution to relieve cyanosis, with a flow of 1 to 3 litres a minute using a mask, rather than an oxygen tent. Laryngeal obstruction due to tenacious mucus may be relieved by a cuffed tracheostomy tube connected to an intermittent positive pressure machine. If symptoms of CO_2 poisoning occur, such as sweating, jerky muscular contractions or mental disturbance, the oxygen must be discontinued temporarily or the rate of administration reduced, and nikethamide (Coramine) injected slowly intravenously in doses of 2 to 8 ml.

Localised Emphysema

(*Compensatory or Secondary Emphysema*)

(*Dilatation Emphysema*)

Definition. Dilatation of the alveoli in localised areas of the lungs.

Etiology. *Compensatory emphysema* is a secondary process around areas of consolidated, fibrosed or collapsed lung. It is thus associated with pneumonia or bronchopneumonia, new growths, an inhaled foreign body, fibrosis, bronchitis and pleural effusion. It may also develop in the remaining lung after lobectomy or pneumonectomy, with consequently increasing dyspnoea. A previously healthy lung will usually expand to fill the additional space without the development of emphysema.

Pathology. Inspiratory efforts, associated with obstruction to the air entry of a localised area of lung, will lead to alveolar dilatation of neighbouring parts of the lung. If one lung is largely put out of

action, as by tuberculous fibrosis, compensatory emphysema will occur in the other. There is no true hypertrophy of lung tissue, but changes similar to those described on p. 173 are seen. The process therefore diminishes the aerating power of the lung.

The condition calls for no special treatment but it is a contra-indication to thoracoplasty or pneumonectomy.

Unilateral Lung Transradiancy

This is a term applied to increased transradiancy of one lung, which is not due to rotation, diminished contralateral transradiancy, compensatory emphysema, or to incomplete bronchial obstruction. The pulmonary arteries are small. Some cases have been discovered by mass radiography.

Atrophic Emphysema

(*Senile Emphysema*)

Definition. Enlargement of the pulmonary alveoli, due to degeneration of their septa.

Etiology. Atrophic emphysema is a variety of senile degeneration. The alternative view is that the emphysema results from rigidity of the spine, and kyphosis, enlarging the antero-posterior diameter of the chest.

Pathology. The lungs, as seen at autopsy, are small, dark and friable. Small bullæ may be present on the surface, and, on section, the enlarged alveolar spaces are seen. The emphysema is non-obstructive.

Clinical Findings. The patient, who is usually over the age of 60, complains of progressively increasing shortness of breath on exertion, and usually he has cough and expectoration due to associated bronchitis.

On Examination: The patient is usually thin and wasted. The chest is flat and expansion is poor. The tactile fremitus is diminished. The percussion note is hyperresonant, but the cardiac and hepatic dulness are not diminished to any degree. The breath sounds are weak and expiration is a little prolonged. Adventitious sounds due to bronchitis may be heard. The diaphragm may be higher than normal.

Treatment. No special treatment is available beyond the care necessary for an elderly patient who is liable to bronchitis or to dilatation of the heart.

Tumours of the Lungs

Simple Tumours. Those which arise in the bronchi have been considered on p. 146. The hamartoma is a common benign tumour. It is composed of cells derived from the various embryonic layers and only contains structures normally found in the organ in which it arises. The cartilage in it may be impregnated with calcium giving a dense shadow on X-ray examination. Other simple tumours include a fibroma.

lipoma, chondroma, leiomyoma and hæmangioma. Arterio-venous fistulæ may also occur in the lungs giving rise to cyanosis and clubbing of the fingers. A murmur is heard over the affected portion of lung and an X-ray film shows a round or lobulated shadow in the lung field.

Malignant Tumours. *Primary carcinoma of the lungs* arises in a bronchus and is described on p. 147. *Secondary carcinoma.* The primary growth may be in the breast, alimentary tract, kidney, prostate, and less frequently in other sites. It is usually bilateral, giving rise to somewhat ill-defined opacities in the lung fields, as seen on X-ray examination. The patient may complain of shortness of breath, loss of weight and malaise. In some cases a bilateral pleural effusion forms. Sarcoma or mesothelioma may be primary or secondary, whereas hypernephroma, malignant deciduoma and seminoma are secondary tumours. *Primary sarcoma.* This is a rare, solitary and rapidly growing tumour occurring in early life. *Secondary sarcoma.* The primary growth is in bone or in a melanotic tumour. *Secondary lymphosarcoma.* In addition to the growth in the lungs enlarged lymph nodes are usually found elsewhere, as in the neck and axillæ, and diagnosis is made by lymph node section. *Secondary teratoma and seminoma.* The primary growth is in the testicle, the secondary growths in the lungs are described as "cannon-ball" tumours on X-ray examination.

Fibrosis of the Lungs

Definition. An excess of fibrous tissue in the lungs.

Etiology. The fibrosis is usually productive in origin, being formed in response to irritation; less frequently areas of replacement fibrosis occur.

Pathology. The fibrous tissue may be distributed in various ways in the lungs. It may be diffuse, as in tuberculosis, sarcoidosis, pneumokoniosis, and in chronic passive hyperæmia. Generalised fibrosis affecting especially the lower lobes may be met with in generalised scleroderma. This may lead to cystic changes. Lobar fibrosis may follow lobar or bronchopneumonia. Peribronchial fibrosis is met with in chronic bronchitis. Localised fibrosis occurs around a tumour, cyst, abscess, or granuloma of the lungs, and after bronchopneumonia. Pleurogenous fibrosis is secondary to chronic pleurisy, fibrous tissue extending into the subjacent lung. When the fibrosis is localised a depressed thickened area may be seen and felt. This is often found at the apex of a lung due to a healed tuberculous focus. With diffuse fibrosis the lung is contracted, firm, and darker than normal. There are often pleural adhesions. On section the lung is tough, the strands of fibrous tissue are apparent, and there may be bronchial dilatation.

Clinical Findings. It is only in the diffuse variety that symptoms are likely to be noted. The patient complains usually of shortness of breath on exertion, with cough and expectoration, especially in the winter. Occasionally unilateral fibrosis will cause dysphagia by torsion on the œsophagus.

On Examination: In a long-standing case there is usually some cyanosis of the face and clubbing of the fingers. If the fibrosis is unilateral, there will be flattening and diminished expansion on one side of the chest, and the cardiac impulse may be seen displaced towards the affected side. The corresponding shoulder may be low, and some scoliosis present. If the fibrosis affects the left upper lobe, cardiac pulsation is usually seen in the second and third left intercostal spaces, close to the sternum, due to uncovering of the heart. Palpation: The diminished expansion is confirmed and tactile fremitus is lessened. Percussion: The note is impaired over the affected lung, and it may be hyperresonant on the other side. Auscultation: The breath sounds are weak over the fibrosed lung, and harsh on the opposite side. Some leathery fibroid râles may be heard, and frequently rhonchi are present in both lungs. Vocal resonance is diminished, and there is no whispering pectoriloquy. If areas of consolidation or excavation are present, the breath sounds are more bronchial in type and voice conduction is increased. Basal fibrosis is often seen in children after bronchopneumonia. The heart is slightly displaced to the affected side, the note at one base is impaired, the air entry weak, and fine to medium râles are heard constantly on deep breathing or after cough.

Differential Diagnosis. The diagnosis of pulmonary fibrosis does not usually present difficulties, but it may be impossible to be certain as to its causation. A Wassermann test should be done, and, if positive, the effect of a course of anti-syphilitic treatment determined. The sputum should be examined several times for tubercle bacilli, and the nature of the predominating organisms investigated. The occupational history of the patient and the X-ray findings may point definitely to pneumokoniosis. Fibrosis of a lower lobe is often the result of pneumonia, bronchopneumonia or pleurisy. This is especially liable to occur in children after bronchopneumonia associated with measles or whooping-cough.

Course and Complications. Fibrosis is usually slowly progressive. It may lead to bronchiectasis, and be accompanied by areas of compensatory emphysema.

Prognosis. In tuberculosis, fibrosis is welcomed as an indication of arrest of the disease. Apart from this, fibrosis limits the functions of the lungs and increases the strain on the heart, and so tends to shorten life. It may also conduce to bronchiectasis.

Treatment. Prophylactic: Adequate inspiratory breathing exercises should be carried out during convalescence in every case of bronchopneumonia, pneumonia and empyema, to expand the base of the lung and prevent fibrosis.

Curative: In basal fibrosis, non-tuberculous in origin, inspiratory breathing exercises should be performed daily, to expand the lung and endeavour to prevent the development of bronchiectasis. Dusty environments should be avoided. The patient must live well within the limits of his respiratory and cardiac reserves, and climatic treatment in the winter is of value in preventing bronchitis.

Diffuse Interstitial Pulmonary Fibrosis

(*Hamman-Rich Syndrome. Fibrosing Alveolitis. Alveolar Capillary Block*)

This is a disease of unknown etiology. It may affect children or adults. There is dyspnoea, cough and eventually right-sided heart failure. Lung biopsy will establish the diagnosis, as there is thickening of the alveolar-capillary barrier due to increase in the number of alveolar cells, fibrinous deposits in the alveolar wall, with eosinophils entangled in interstitial fibrous tissue. It may be associated with arthritis. Occasionally improvement occurs with corticosteroids.

It has been suggested that it is a localised form of collagen disease. It is characterised by progressive dyspnoea, cyanosis, cough, pain in the chest and eventually right-sided heart failure. Diagnosis may be made in life by lung biopsy, the microscopical changes being characteristic. Fibrous tissue forms in the alveolar walls and later spreads to invade the lungs. The condition is progressive and death usually occurs within 12 months of the onset of symptoms.

Pulmonary Hæmosiderosis

Focal deposits of hæmosiderin in the lungs may be met with in two main conditions. 1. *Idiopathic pulmonary hæmosiderosis*. 2. *Cardiac pulmonary hæmosiderosis* which is often referred to as brown induration of the lung. Neither of these conditions appears to lead to diffuse pulmonary fibrosis.

1. *Idiopathic pulmonary hæmosiderosis* is most commonly met with in children and young adults. This is a rare disease which is usually, but not invariably, rapidly fatal. It is associated with severe cases of hypochromic anæmia leading to secondary hæmorrhage in the lung tissue. In the acute stage the patient may appear to have a severe respiratory infection. During remissions pallor, cough and recurrent small hæmoptyses occur. The sputum may show macrophages containing hæmosiderin. X-ray examination of the chest shows fine mottling of the lung fields with enlargement of the root shadows.

In another group of cases recurrent hæmoptysis is associated with glomerulonephritis (*Goodpasture's syndrome*), and changes in the lungs, similar to those described in idiopathic hæmosiderosis, are noted. There is no definite evidence that corticosteroids are of value.

2. *Cardiac pulmonary hæmosiderosis* is usually connected, in early adult life, with rheumatic carditis and mitral stenosis. It has also been described in association with left ventricular failure. In addition to hæmoptysis the characteristic miliary mottling of the lungs is shown by X-ray examination, especially in the middle and lower zones.

Pulmonary Alveolar Microlithiasis

The alveoli are obstructed by microliths. X-rays of the chest show fine areas of calcification in the lung fields, and the patient, a child or adult, notices shortness of breath. Scattered râles are heard over the lungs, and the fingers are usually clubbed.

Pneumoconiosis

(Dust Disease of the Lungs)

Definition. Fibrosis of the lungs, due to inhalation of dust.

Etiology. The following varieties are described, according to the nature of the irritant: *Anthracosis* (coal). *Silicosis* (silica) as in the following occupations:—Gold, tin, zinc or hæmatite iron ore, and coal mining; sandblasting; flint and pebble crushing; the manufacture of abrasive soaps; metal grinding; slate quarrying; granite, sandstone and pottery work. Workers in mica, talc and those exposed to bauxite fumes. *Lithosis* or *chalicosis* (stone particles). *Siderosis* (tin, copper, lead or iron), this is possibly silico-siderosis. *Asbestosis* (metallic particles containing silica and iron, and also vegetable fibres). Asbestos workers are employed in making matches, filters, paints, roofing tiles, brake linings, etc. *Byssinosis* (cotton particles). *Bagassosis*. The bagasse dust, which contains about 6% of silica, may be inhaled in bread-making factories. Bagasse is sugar cane, which has been broken down, and from which sugar has been extracted. *Berylliosis*. Beryllium is used in the manufacture of fluorescent lamps. In chronic beryllium poisoning nodules appear in the lungs. Berylliosis behaves like a granuloma and dissemination occurs in the liver. *Farmers' lung*. This is due to inhalation of dust from mouldy hay and grain. It may be acute or chronic, and may respond to corticosteroids. *Bird Breeder's (fancier's) lung*. This resembles farmer's lung as it is produced by the inhalation of antigens in pigeons' and budgerigars' excreta. There is fever, cough, dyspnoea and râles are heard in the lungs. The carbon-monoxide transfer in the lungs is impaired.

Pathology. When particles of dust are inhaled for long periods, fibrotic and bronchitic changes ensue in the lungs. It is very doubtful whether in man the particles reach the lungs from the alimentary tract and the lymphatic system. Coal-dust particles are to a certain extent expectorated, but silica particles tend to remain in the lungs, and pulmonary tuberculosis is very prone to supervene. Tuberculosis may occur in coal-miners, but it is common in gold-miners, and it also occurs in some cases of asbestosis. Dusts containing free crystalline silica (SiO_2) are dangerous, providing the particles are smaller than 10 microns in diameter, and their inhalation leads to the formation of silicotic nodules and to fibrosis. Tuberculosis may supervene. It is now believed that the silica produces fibrosis, not by mechanical irritation, but rather as the result of the solubility of the silica. The lesions are nodular and distributed throughout the lungs. It has been shown experimentally that the evil effect of quartz dust is reduced by coal dust and practically abolished by shale. This is probably due to the fact that the solubility of the quartz is reduced by coal, because aluminium is released which forms a covering over the quartz particles and so lowers their solubility. Silicosis is not uncommonly combined with anthracosis in coal-miners' lungs. Anthracosis occurs in two forms. In the simple variety there are minute nodules, chiefly in the upper and middle zones of the lungs. Deposits of dust may be surrounded by

areas of focal emphysema. In the complicated form there are large localised opacities seen by X-rays, and tuberculous fibrosis develops. The outlook in this variety is very unfavourable. In anthracosis the lungs, as seen at autopsy, are black; in silicosis they are grey; and in siderosis they are brown. They are firm and contracted, due to nodular or diffuse fibrosis, and the pleura is thickened with adhesions. The bronchi are often dilated and the root lymph nodes are enlarged, hard and pigmented. In asbestosis silica is combined with such bases as magnesium, iron, calcium, sodium and aluminium, and there is diffuse interstitial fibrosis of the lower lobes. Examination of the lungs of silver finishers, who inhale iron oxide dust, has shown that the stippled or reticular X-ray shadows are due to the aggregations of iron oxide dust, and not to fibrotic changes.

Clinical Findings. The patient is usually a male between the ages of 20 and 40, who gives a history of having worked for some years (usually over 6) in one of the dusty occupations mentioned above. He complains of cough and expectoration, with shortness of breath, and, later, of lassitude and loss of weight.

On Examination: In the early stages the only abnormalities are those detected by the X-rays. In silicosis small nodules of fibrous tissue may be seen in the lung fields, with diffuse streakiness of the lungs and heavy root shadows. The nodular shadows become more obvious as the condition progresses, and, later, a diffuse mottling occurs, chiefly in the central zones of the lungs. In asbestosis there is a reticular fibrosis. The physical signs in an established case are chiefly those of chronic bronchitis and emphysema, the air entry over both lungs being weak. The sputum in asbestosis may contain microscopical golden-yellow "asbestosis bodies," with bulbous extremities, consisting of a central core of asbestos surrounded by discs which give the Prussian blue reaction for iron, and are probably composed of iron silicate.

Some cases of acute silicosis have occurred in workers in a factory manufacturing a cleaning powder containing ground silica, sodium carbonate and soap. The alkali is probably responsible for the rapid onset of the symptoms. Death occurred in two cases, and in one of them tuberculous lesions were also demonstrated in the lungs. Cases have also been described in tunnellers and in rock drillers in lead mines. The symptoms of farmers' lung resemble those of asthma.

Differential Diagnosis. The diagnosis of silicosis can usually only be established by X-ray examination of the lungs.

Course and Complications. The course is progressive, unless arrested by removal of the patient from the noxious environment. Complications include bronchitis, bronchiectasis, emphysema, tuberculosis and cardiac dilatation. Silicosis is occasionally followed by carcinoma of a bronchus. Asbestosis may cause mesothelioma of the pleura, pleural plaques and be associated with bronchial carcinoma.

Prognosis. This is unfavourable unless the patient is removed from his dusty occupation in the early stages of the disease.

Treatment. Prophylactic: Measures should be taken in all dusty

occupations to prevent inhalation of the dust. These include the use of respirators, water sprays incorporated in the coal drills, and fans. The workers should be examined and X-rayed every 6 months.

Curative : The patient should be removed from his occupation. The treatment then is as for chronic bronchitis and emphysema. Berylliosis may be treated with cortisone or ACTH.

Syphilis of the Lungs

The condition is usually congenital, rarely acquired.

Pathology. In congenital syphilis a condition of "white pneumonia" is usually present. A lobe, or the greater part of one or both lungs, may be involved. The affected portion is enlarged, and depressions caused by the pressure of the ribs may be seen on the surface. The lung appears pale and dry and sinks in water. On section the lung may somewhat resemble the tissue of the pancreas ("pancreatisation"). The alveolar epithelium is degenerated, and the alveoli contain some leucocytes. There is round-celled infiltration of the interalveolar tissue with numerous small gummata. The *Treponema pallidum* is present. In acquired syphilis the lesion may take the form of a gumma.

Clinical Findings. The infant with congenital syphilis of the lungs is still-born, and the lesion is demonstrated at autopsy, or death occurs after a few days, during which signs of pulmonary consolidation may have been detected. The Wassermann reaction of the blood, both of the mother and child, is generally positive, and other stigmata of congenital syphilis are noted. In adults the clinical findings are those of a local pulmonary tumour, or of a blocked bronchus if the gumma is situated intrabronchially. Bronchoscopy, the positive Wassermann reaction, and the response to anti-syphilitic treatment are of value in diagnosis.

Actinomycosis of the Lungs

Etiology. The causative organism is the *Actinomyces bovis* (*Streptothrix actinomyces* or ray fungus). This may gain access to the lungs from the teeth or tonsils.

Pathology. Granulomatous lesions are found in the lungs, often in the lower lobes. Suppuration and fibrosis occur around them, and they may spread to involve the pleura, chest wall or liver.

Clinical Findings. The history of the case may closely resemble that of chronic pulmonary tuberculosis or of a neoplasm of the lungs. Thus the patient complains of cough, expectoration which may be bloodstained, progressive loss of weight and irregular fever. The first symptom may be pleural pain.

On Examination : The physical signs in the lungs are very variable. Thus they may be those characteristic of bronchitis, or of an area of consolidation or excavation of the lung. In other cases there is dry or wet pleurisy. The lesion may ulcerate through the chest wall, producing a purulent discharge containing "sulphur" granules. The sputum should be specially examined for the ray fungus, by the appropriate staining methods.

Differential Diagnosis. This may be very difficult before the organism is found in the sputum or pleural fluid. The X-ray findings often closely resemble those of chronic pulmonary tuberculosis or of carcinoma of the lung.

Course and Complications. The course is usually slowly progressive, the infection may spread elsewhere, especially to the liver or chest wall.

Prognosis. The outlook has been improved by modern treatment.

Treatment. A prolonged course of treatment with benzylpenicillin should be given, injecting intramuscularly one million units (600 mg.) every 6 hours for 1 to 2 months. Sulphadiazine may be combined with the penicillin treatment, 1 G. t.d.s. for 14 days. If this fails potassium iodide should be given in increasing doses, beginning with 5 gr. (0.3 G.) t.d.s., and working up to 60 to 90 gr. (4 to 6 G.) t.d.s. Cutaneous sinuses may be treated with deep X-ray.

Aspergillosis of the Lungs

Etiology. Infection with a fungus the *Aspergillus fumigatus*. The infection is spread by grain.

Clinical Findings. The patient is usually a miller, farm worker or pigeon breeder. He complains of symptoms resembling those of chronic pulmonary tuberculosis; more rarely he is acutely ill. Aspergillosis may complicate pulmonary infections treated by antibiotics.

The diagnosis can only be made if the organism is found in the sputum. The acute case is liable to be mistaken for lobar pneumonia. The sputum may contain whitish flecks, composed of masses of mycelial threads, and no other organisms. Rapid recovery follows the administration of potassium iodide.

Treatment. This consists in administering potassium iodide, as for actinomycosis.

Moniliasis (Candidiasis) of the Lungs

Etiology. The causative organisms are various fungi of the monilia group. It is met with among tea tasters in Ceylon. Monilia are often present in the bronchi of apparently healthy individuals or in chronic lung disease such as bronchitis. They may become pathogenic when other bacterial flora have been eliminated by the use of antibiotic drugs.

Clinical Findings. The patient complains of symptoms resembling those of chronic bronchitis, and the causative organisms are found in the sputum.

Treatment. This consists in the administration of potassium iodide, in gradually increasing doses from 5 gr. (0.3 G.) to 60 gr. (4 G.) t.d.s.

North American Blastomycosis

Etiology. This is a systemic infection with the *Blastomyces dermatitidis*, which occurs only in the yeast form in human beings. It is widespread in the United States and in Canada.

Clinical Findings. In the pulmonary variety the patient has a cough and sputum. X-ray examination shows shadows suggesting confluent pneumonic areas, often with cavitation. The skin is frequently involved, chronic abscesses forming on the face, hands, wrists and ankles. The lesions may be widely disseminated throughout the body. The diagnosis is made by finding the causative organism in the sputum or skin lesions. The disease is usually fatal within a few years.

Treatment. Stilbamidine may be given by slow intravenous injection. After a preliminary test of 50 mg., 150 mg. are injected daily in 300 ml. 5% dextrose solution. The course usually lasts about a month. In some cases this is followed by trigeminal neuralgia.

It is said that patients treated with amphotericin B (Fungizone), which is isolated from the *streptomyces nodosus*, are less liable to relapse than those to whom stilbamidine has been administered.

Amphotericin should be given intravenously, and only in hospital. The dose is 0.25 mg./kg. body weight, increased to 0.5 mg. and later to 1 mg./kg. body weight. It is put up in 20 ml. vials, providing, on reconstitution, 50 mg. of amphotericin activity. For intravenous infusion the concentration recommended is 0.1 mg./ml. It is diluted with 5% Dextrose Infusion B.P. of pH above 5.0. The makers' instructions (E. R. Squibb & Sons Ltd.) should be carefully followed. The volume infused is usually about 600 ml., and it should be given daily slowly, at a rate of 100 ml./hour. The dose is reduced, when improvement is noted, to alternate days, the treatment lasting about 4 to 8 weeks. A check should be kept on the kidney, liver and bone marrow function during prolonged treatment.

Collapse of the Lungs

(Pulmonary Atelectasis)

Varieties. *Congenital pulmonary collapse* is met with in still-born infants, or in those in whom the respiratory efforts are very feeble, or where there is obstruction to the air-way.

Acquired pulmonary collapse is of two varieties, relaxation and compression collapse, and absorption collapse.

Relaxation and Compression Collapse

Etiology. *Relaxation collapse* may be due to conditions which reduce the size of the thoracic cavity, such as a thoracoplasty, diaphragmatic hernia, a pleural or pericardial effusion, or a pneumothorax in which the intrapleural pressure is below zero. In these cases the elastic recoil of the lungs comes into increased action. *Compression collapse* results from a pleural effusion or pneumothorax in which the pleural pressure is positive.

Absorption Collapse

Etiology. This results from bronchial obstruction, the air in the alveoli beyond the blockage being absorbed, and the portion of lung supplied by the bronchus collapsing. The obstruction may be within

or without the bronchus. A foreign body, such as an acorn, may lodge in the main bronchus, the whole lung collapsing. The obstruction is more often caused by plugs of mucus, in which case a segment, a lobe or the whole lung may be affected. This may occur in acute bronchitis, in influenza, or after an operation, especially on the upper abdomen. It is also met with in post-diphtheritic paralysis, in poliomyelitis, after injection of iodised oil into healthy bronchi, and in association with hæmoptysis. Other causes include a new growth, or gumma of a bronchus, the pressure of an aneurysm, fibrosis or consolidation of the lung. When fluid replaces air in the partially collapsed segment or lobe a *consolidation collapse* results, and this may lead to an *infected atelectasis*.

Clinical Findings. The signs of local areas of collapse are dulness and weak air entry. These are often met with in influenza, and change rapidly from day to day, as the collapsed portion of lung re-expands and another zone collapses.

An important clinical condition which may occur in children or young adults is due to *infected mucus from the naso-pharynx being inhaled into a bronchus*. The patient is suddenly taken ill with a high fever, 103° or 104° F. (39.4° or 40° C.), and careful clinical examination will reveal a small area of weak breath sounds, with, perhaps, a few râles.

Segmental areas of collapse give rise to small linear shadows on X-ray examination. Collapse of the right middle lobe is characterised by a triangular shadow, seen best in the lordotic and lateral X-ray films.

Treatment. Re-expansion of the collapsed area of lung rapidly follows expectoration of the obstructing mucus plug. Tilting over a chair, deep breathing, coughing, slapping the chest over the affected side, rolling the patient from side to side, and the inhalation of 7% carbon dioxide and 93% oxygen are all measures which may be employed. Bronchoscopic aspiration is rarely necessary.

Massive Collapse

Etiology. The whole lung or a lobe may collapse. It follows operations especially upon the upper abdomen and is known as *post-operative massive collapse*. It also occurs after injuries to the abdomen or legs in which the chest is not involved. It may be met with in one lung when there is a non-penetrating wound on the opposite side of the chest.

The reason why it occurs after major upper abdominal operations is because the patient is prevented from breathing deeply with the lower lobes and from coughing up mucus, by tight abdominal bandages, by pain resulting from the operation, and by the calming effect of sedative drugs. This allows mucus to accumulate in and obstruct a main lobar bronchus. Some cases may be due to nervous reflexes inhibiting the movements of the diaphragm or intercostal muscles, or resulting in reflex constriction of the bronchioles with inspiration, expiration being normal, so that the lung is deflated with respiration.

Clinical Findings. The patient is cyanosed in some instances. In the early stages the affected side of the chest is immobile and the

air entry is very weak over the affected lung, usually over the lower lobe. The heart is displaced to the affected side. The temperature, and pulse and respiration rates are raised. Later, there is dulness over the affected lobe, with bronchial or tubular breathing, whispering pectoriloquy and bronchophony and a few fine râles. The breath sounds over the opposite lung are harsh, and the percussion note may be hyperresonant. There is usually some frothy expectoration. X-ray examination shows displacement of the mediastinum to the affected side with elevation of the diaphragm. The ribs become approximated, giving a tiled appearance. The collapsed lung casts a shadow which may be sufficiently dense to obscure the ribs.

Differential Diagnosis. Before massive collapse was clearly described by my chief, Pasteur at the Middlesex Hospital, London, in 1908, it was usually mistaken for post-operative pneumonia. The chief distinguishing features are the homolateral cardiac displacement, the absence of rusty sputum and labial herpes, and the course of the illness, which is more rapid than that of pneumonia. The diagnosis is confirmed by X-ray examination, by which the collapsed part of the lung and the raised cupola of the diaphragm are revealed. The chief conditions which have to be excluded are pulmonary thrombosis or embolus, and in left-sided affections, a spontaneous pneumothorax, as the stomach resonance with a massive collapse may extend up as high as the fourth rib. This gives a hyperresonant note which may be thought to be due to air in the pleura.

Course and Complications. In about 2 or 3 days the affected lung may re-expand, the dyspnoea cease and the temperature, and pulse and respiration rates fall to normal. Pleurisy, bronchitis, pneumonia, bronchiectasis and abscess may occur as complications.

Prognosis. This is usually good, unless the collapse is bilateral or due to poliomyelitis, or unless pneumonia supervenes.

Treatment. Prophylactic: In any case in which there are signs of bronchitis the patient should be given a course of penicillin injections for a few days before the operation. He should be encouraged to take periodically a few deep breaths after the operation. The inhalation of 7% carbon dioxide in 93% oxygen for a few minutes at the end of an anæsthetic assists in ventilating the lungs. Changes of position in bed and the avoidance of binders which constrict the lower ribs are of first importance.

Curative: Bandages restricting the lower part of the chest should be loosened and the patient laid on his back, flat in the bed, and rolled from side to side 12 times. This simple manoeuvre is often surprisingly successful even when a lobe has been collapsed for several days. The breathing and pulse rapidly subside in rate, and the obstructing plug of mucus may be expectorated. The chest may also be firmly tapped over the collapsed lung, the patient lying on his side, with the collapsed lung uppermost. Subsequently the patient should inhale a mixture of oxygen and 7% carbon dioxide for several hours. Nikethamide (Coramine) 2 ml. should also be given subcutaneously every 6 hours if the patient is collapsed. If these measures fail a bronchoscopic

aspiration may be performed to remove any mucus present. Sulphadimidine or penicillin should be given for a week or so after re-expansion has taken place.

Hyperæmia of the Lungs

There are two varieties of hyperæmia of the lungs, or, as it is often called, of congestion of the lungs, active and passive.

Active hyperæmia. This is associated with inflammatory lesions of the lungs, a pulmonary infarct, or the inhalation of poison gas.

Passive hyperæmia. The outflow from the lungs through the pulmonary veins may be diminished in heart failure, chronic bronchitis and emphysema. It is met with especially in elderly bed-ridden patients, constituting hypostatic congestion. Infection may supervene with rise of temperature, thus resulting in what has been called hypostatic pneumonia. The pulmonary veins are at times obstructed by enlarged mediastinal lymph nodes or by thrombosis.

Hæmorrhagic Concussion of the Lungs

(Blast Injury of the Lungs)

Etiology. Hæmorrhagic lesions are often found in the lungs, especially in children, from peace time injuries such as road accidents, in which no injury to the chest wall and no fracture of the ribs can be found. Blast from a high explosive bomb may kill without signs of enlarged mediastinal lymph nodes or by thrombosis.

Pathology. Hæmorrhagic areas are found usually deep in the lungs, and often at the costo-phrenic sinus, when the spleen or liver is also damaged. There may also be hæmothorax and effusion of blood into the mediastinum.

Clinical Findings. The patient may be found dead, as described above, or complain of faintness, shortness of breath and pains in the chest or abdomen.

On Examination: Patients are seen to be suffering from varying degrees of shock. In addition there is dyspnoea chiefly of an expiratory type, the chest being over-distended and bulging. The physical signs in the lungs vary, the breath sounds are often weak throughout both lungs and a sudden rise of temperature may herald the development of a lobar or lobular consolidation. Abdominal pain, tenderness and muscular rigidity are met with in some cases, suggesting an acute abdominal condition. Hæmoptysis of varying degrees may occur, and restlessness is a predominant feature in all cases of blast injuries to the lungs. Ruptured ear drums are to be expected if the person has been sufficiently close to the explosion to suffer internal injuries from blast.

Treatment. Shock should be combated by placing the patient in a bed heated with hot bottles or an electric cradle. Morphine sulph. $\frac{1}{2}$ gr. (15 mg.) should be given subcutaneously to control restlessness and severe pain, and, if necessary, repeated up to a maximum of 1 gr. (60 mg.) in 24 hours. Oxygen should be inhaled from a mask. Plasma transfusions of 1 to 2 pints (600 to 1,200 ml.) are often helpful, but whole blood transfusions are only required if there is anæmia.

Acute Œdema of the Lungs

Definition. A condition in which the pulmonary alveoli are suddenly flooded with serous exudate.

Etiology. The cause is not known. Probably there are several varieties. There are three main views. 1. The cardiac theory: The œdema is considered to be a manifestation of sudden left-sided heart failure, perhaps due to a disproportion between the effective power of the ventricles, the left expelling less blood than the right. It may occur in association with paroxysmal atrial flutter. 2. The toxic theory: This may account for certain cases met with in connection with chronic nephritis, pregnancy and infectious diseases, in which no cardio-vascular lesion is demonstrable. 3. The angio-neurotic theory: This helps to explain the sudden onset of the condition in young people, apparently in perfect health, and is supported by the simultaneous appearance of œdema of the face.

Clinically, acute œdema of the lungs is most often associated with arteriosclerosis, aortic disease, myocardial degeneration, coronary occlusion, pulmonary infarction and chronic nephritis. Less frequently it occurs as a complication of aspiration of a pleural effusion. It may occur at high altitudes, over 11,000 feet (3,666 metres). It may also be associated with intracranial and spinal injuries.

Clinical Findings. The patient is usually over the age of 40. Apparently in normal health, he is suddenly seized with faintness and apprehension and then becomes very short of breath and may rapidly pass into a stage of semi- or complete unconsciousness.

On Examination: If the patient is conscious he is found sitting up and alarmed, with great distress of breathing. The skin is pale and moist, and slight cyanosis is present. The heart is usually regular, but rapid. Râles are heard all over both lungs. After a period varying from a few minutes to half an hour frothy fluid wells up into the mouth from the lungs, and may stream out through the mouth or nostrils. The fluid is often stained pink. Transient proteinuria may occur.

Differential Diagnosis. In practice there is little difficulty in diagnosis, the physical signs in the lungs and the frothy expectoration are characteristic.

Course and Complications. The attack may last for a few minutes or for several hours. As many as 70 attacks have been recorded in the same patient.

Prognosis. The first attack may prove fatal; the prognosis is always extremely grave if the patient loses consciousness.

Treatment. A hypodermic injection of morphin. sulph. $\frac{1}{2}$ gr. (20 mg.) and atropin. sulph. $\frac{1}{50}$ gr. (1 mg.) should be given immediately. The morphine should be repeated in 2 hours if necessary, and oxygen administered by nasal catheter or mask. Diuresis may be promoted by the intravenous or intramuscular injection of frusemide (Lasix), 20 mg. in 2 ml. ampoule, or by the oral 40 mg. tab. If this treatment fails 10 to 15 oz. (300 to 450 ml.) of blood should be removed from a vein in the arm. Lumbar puncture is usually of no avail. The congestive heart

failure should be treated with digitalis by mouth, aminophylline 250 mg. in 10 ml. sterile water, by intravenous injection, by a salt poor diet and diuretics.

Chronic Œdema of the Lungs

This occurs in association with passive hyperæmia (see p. 187) and as a manifestation of œdema in renal disease.

Infarction of the Lungs

Definition. Obstruction of a branch of the pulmonary artery, with resultant hæmorrhage into the lung alveoli and interstitial tissues.

Etiology. There are two varieties, the embolic and the thrombotic.

Pulmonary embolus. This is the most common cause. The embolus may consist of blood clot, of a fragment of an intracardiac vegetation, less frequently of air, of particles of fat or of new growth, of parasites such as a hydatid daughter cyst, or of droplets of amniotic fluid containing meconium. **Predisposing causes:** Cardiac disease, such as mitral stenosis, bacterial endocarditis, venous stasis, and childbirth. Surgical cases are most commonly secondary to operations in which the anterior abdominal wall has been incised. This tends to lead to stagnation in the iliac veins and their tributaries owing to inhibition of diaphragmatic respiration caused by pain in the wound, with consequent venous thrombosis. Pulmonary embolus is also comparatively common in cases of fractured femur, probably due to venous stagnation, caused by the immobilisation of the limb. Fat embolus may also result from a severe shaking, multiple and compound fractures, car accidents, serious burns, etc. Sepsis does not appear to play an important part in the etiology of pulmonary embolus. Air embolism has been recorded as a complication of pneumoperitoneum, of vaginal douching with soapy water during pregnancy in attempts at abortion, air in the form of froth being introduced into the uterus under considerable pressure, and of insufflation of the vagina with a silver picrate powder in the treatment of a vaginal discharge. It has also occurred during blood transfusion as the result of raising the pressure in the bottle by a Higginson syringe while the filter was partly blocked.

Pulmonary thrombosis. This may occur in any acute or chronic lung disease, in mitral stenosis, and also as a secondary process in connection with a pulmonary embolus. It may also be a manifestation of phlebitis migrans, or occur after operations. Thrombosis of the major pulmonary arteries may result in acute or chronic cor pulmonale.

Pathology. The pulmonary embolus, when formed of blood clot, may be derived from one of the veins in the abdomen or legs. It is detached and carried through the right side of the heart to the lungs. It may also be formed from blood clot in the right atrium in cases of congestive heart failure, or in mitral stenosis. Air embolus may result from an operation on the chest wall, as in exploring an old empyema track. Recent infarcts resemble blood clot, whereas old ones become absorbed and replaced by fibrous tissue. When the infarct extends to the lung surface, it is cone-shaped, with the base outwards, and evidence of dry

pleurisy is seen on the surface. Deep-seated infarcts are oval or circular. The infarct sinks in water. It is not always possible at autopsy to discover the source of the embolus.

Clinical Findings. In a typical post-operative case, there is a history of an operation about 10 days previously. The patient is suddenly seized with agonising pain in the side of the chest, which is intensified with each inspiration. There may also be cough, and the immediate expectoration of blood, or of blood and frothy sputum. The pain may be so severe that the patient collapses.

On Examination: The patient is found sitting up in bed, often leaning over towards the affected side, much distressed, with rapid and shallow respirations. There may be no physical signs in the lungs in the early stages, beyond generalised weak air entry. In a few hours an area may be detected in which there is slight dulness, with definitely deficient breath sounds and a few fine râles as œdema occurs around the infarct. Later a pleural friction rub may appear, with signs of consolidation of a portion of the lung, usually in the lower lobe. If the infarct is basal, involving the diaphragmatic pleura, the pain is referred to the tip of the corresponding shoulder. The temperature, and pulse and respiration rates are raised. All cases do not conform to this type. There is the cardiac variety, in which the patient, after an operation, suddenly becomes pale and collapsed, suffers no pain, is dyspnoic, and dies in a few minutes. Such cases are mistaken for heart failure until the post-mortem examination reveals the presence of a pulmonary embolus. There is also a cerebral or apoplectiform variety. Here the patient, who has been convalescing from an operation for about 2 weeks, and who perhaps is just getting out of bed, suddenly falls unconscious, is cyanosed, and has stertorous breathing. Death occurs in a few hours, and at the autopsy no cerebral hæmorrhage is found, but a pulmonary embolus is present. With fat embolism there is a symptom-free interval of a few hours to 2 days. This is followed by dyspnoea, pallor, cyanosis, restlessness and sweating. The patient is very ill and brings up frothy sputum which may be blood-tinged. Fat globules may be found in the sputum. Maternal pulmonary embolism due to amniotic fluid is said to be the commonest cause of death during labour and the following nine hours. It is associated with excessive uterine contractions and amniotic fluid containing meconium. Lesser degrees of severity may cause post-partum shock and collapse.

Differential Diagnosis. This is usually easy when there is severe pain in the chest. Hæmoptysis occurring in mitral stenosis is generally considered to be due to an infarct in the lungs, rather than to passive hyperæmia.

Course and Complications. The signs of an infarct in the lungs usually persist for about 1 to 2 weeks, and the sputum may contain blood for about 7 to 10 days. Further infarcts may occur at short intervals. If the embolus is infected, abscess of the lung may ensue.

Prognosis. This is very grave if the infarct is large, and in the cardiac and cerebral types of cases.

Treatment. Prophylactic: After abdominal operations, and in

fractures especially of the femur, costal and diaphragmatic respiration should be as free as possible, and general muscular contractions and leg movements encouraged. If venous thrombosis occurs in a limb anticoagulants should be given. It is doubtful whether getting the patient up on the second or third day after a major operation has diminished the incidence of post-operative thrombosis.

Curative: The immediate treatment of a pulmonary infarct is directed to the relief of pain and the alleviation of shock. Pain is most effectually abolished by strapping the affected side of the chest, from below upwards, in a position of full expiration. The strapping should include portions applied across the top of the shoulder from before backwards. A hypodermic injection should be given of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) and atropin, sulph. $\frac{1}{120}$ gr. (0.5 mg.).

Anticoagulants should be administered to diminish the coagulability of the blood. *Heparin* may be given intravenously or intramuscularly. It is put up in 5 ml. rubber-capped vials containing 1,000, 5,000 and 25,000 international units per ml. One hundred units equals 1 mg. of heparin.

Heparin should be injected intravenously directly the patient is seen, the dose being 15,000 units. Four hours later 10,000 to 12,500 units should be injected intramuscularly, with 0.5 ml. of 2% procaine mixed with each injection to reduce pain, every 8 to 12 hours for 48 hours. The clotting time should be prolonged by this method up to about 20 minutes (normal 4 to 7 minutes by the Lee and White method).

Phenindione (Dindevan) should be given by mouth simultaneously, the first dose at the same time as the intravenous injection of heparin, and repeated in 12 hours. The dose is 100 mg. (2 tablets). On the next day 50 mg. is given every 12 hours, and subsequently 25 to 75 mg. daily. The amount of phenindione required is determined by daily estimations of the prothrombin time. This should be prolonged to between 28 and 36 seconds (normal, 14 to 18 seconds). This is the simplest guide. The prothrombin time of the patient should be about twice the time of the control. From this the prothrombin concentration can be worked out. This should be kept at between 20% and 30% (normal 70% to 140%). If it rises, more phenindione is required, if it falls below 20% the phenindione should be omitted for a day. The prothrombin index is the control prothrombin time, divided by the patient's prothrombin time, multiplied by 100. This should be kept at between 40% and 50% (normal 95% to 110%). The urine of the patient taking phenindione may be orange-red in colour. This is of no significance. It should be tested daily for blood. Aspirin should not be given with anticoagulants.

If hæmorrhage occurs the anticoagulant should be stopped. If the bleeding is due to heparin the clotting time can be quickly restored to normal by the intravenous injection of 10 ml. of 1% protamine sulphate solution. Hæmorrhage due to phenindione should be treated by the intravenous injection of 10 mg. of vitamin K (Synkavit), or 20 to 25 mg. can be given by mouth. Alternatively a blood transfusion of 1 pint (600 ml.) may be given.

Phenindione should not be given for longer than 4 to 6 weeks, owing

to the risk of complications, such as fever, rashes, bronchitis, diarrhoea, steatorrhoea, jaundice, renal damage, giddiness, tremors, sweating, aplastic anæmia, orange discolouration of the hands and nails, etc. It should not be given in cases of cirrhosis hepatis.

In cases in which the heart has stopped beating, immediate embolectomy has been performed with some success. The base of the pulmonary artery is opened and the clot removed.

Hæmoptysis

Definition. Spitting of blood.

Etiology. Hæmoptysis may be true or spurious. In true hæmoptysis the blood is derived from the larynx, trachea, bronchi or lungs, whereas in spurious hæmoptysis the source of the bleeding is above the larynx.

The causes are very numerous. *True hæmoptysis:* Bronchial carcinoma is a frequent cause, next to which come mitral stenosis, associated with pulmonary infarct, and congestive (left ventricular) failure. Other fairly common causes are tuberculosis, pneumonia, bronchopneumonia, infarction from any cause, and bronchiectasis. Less frequently hæmoptysis is due to a simple tumour of the bronchus such as an adenoma or angioma, secondary carcinoma, hereditary telangiectasis, abscess or gangrene of the lungs, congenital cystic disease of the lungs, bronchitis, spirochætal bronchitis, paragonimiasis, actinomycosis, hydatid infection, bilharziasis, pneumokoniosis, erosion of the lung by a pneumolith (*hæmoptysis calculosa*) and to Goodpasture's syndrome in which there is also glomerulonephritis. Penetrating wounds of the lungs, due to a foreign body or fractured rib, or due to puncture of the lung in pneumothorax treatment are sometimes met with. Hæmoptysis may also be due to blood diseases such as purpura, leukaemia, hæmophilia, or pernicious anæmia; to deficiency diseases such as scurvy or lesser degrees of vitamin C insufficiency; to lack of vitamins P or K; or to the hæmorrhagic forms of small-pox and measles. It is at times associated with a high blood pressure, arteriosclerosis, polyarteritis nodosa and emphysema. There is probably no such thing as hæmoptysis due to vicarious menstruation. An aneurysm may erode into a main bronchus or into the trachea and cause a recurrent "weeping" of blood, or a fatal hæmorrhage. Other tracheal and bronchial causes include tumours, the infective granulomata such as tuberculosis or syphilis, and erosion of a caseous tuberculous lymph node.

Hæmoptysis in children or young adults is occasionally due to *idiopathic pulmonary siderosis*. The clinical picture is that of a child with anæmia the cause of which is obscure. The sputum does not usually contain fresh blood, but is reddish-brown due to hæmosiderin. It is thought that the disease may be due to an increased permeability of the pulmonary capillaries. There is damage to the elastic tissue of the lungs, with deposits of hæmosiderin and fibrotic changes in the lungs.

Spurious hæmoptysis: The bleeding comes from the gums, from pharyngeal varices or from the nose. It is sometimes self induced and

a form of malingering. Betel nut chewing in India and Ceylon may simulate hæmoptysis.

Clinical Findings. These vary with the amount of blood expectorated. Thus the sputum may be stained with blood, small dark clots may be expectorated, or there may be a frank hæmoptysis of bright frothy blood of several ounces, or a profuse discharge of a pint (600 ml.) or more of blood may occur. The sputum usually contains blood for 2 or 3 days, the colour becoming darker after the bleeding has stopped, and stale blood is expectorated. Unless the bleeding is severe, the patient is unaware of it until he sees the sputum. In a sudden hæmoptysis, in which pure blood comes up, he may just "clear his throat," taste and feel a saltish warm sensation in the mouth, and then spit out the blood. Rupture of a vessel into a pulmonary cavity may cause death in a few minutes, whereas if an aneurysm bursts into a bronchus, the patient falls dead in a few seconds. In pulmonary tuberculosis hæmoptysis is more common in hot weather, and in the majority of cases it occurs when the patient is at rest. In some cases hæmoptysis leads to lobar collapse of the lungs. Deficiency of vitamins C or P may be accompanied by lowered capillary resistance and by a tendency to spontaneous petechiæ and ecchymoses. Lack of vitamin K may be associated with chronic cholecystitis, jaundice and hypoprothrombinæmia and result in hæmoptysis from an old-standing tuberculous cavity.

Differential Diagnosis. The diagnosis of hæmoptysis presents no difficulty if the patient is seen during an attack. If there is only the history to help, there may be great difficulty in differentiating it from hæmatemesis. Attention should be paid to the following points: Was the blood coughed up or vomited? Is there a history of previous chest trouble, or of indigestion? Did the patient feel faint before the blood came up, as often is the case with hæmatemesis. Was there food mixed with the blood? Was the blood of a brownish colour, due to the action of gastric juice, or was it bright and frothy? Was there blood in the sputum for some days subsequently? Did melæna occur after the hæmorrhage? Melæna is not absolutely diagnostic of hæmatemesis, as blood may be swallowed in a severe hæmoptysis. If the blood is actually seen, the reaction to litmus should be tested. In hæmatemesis it is acid, unless the patient has taken a large dose of alkali just before the bleeding took place, whereas in hæmoptysis the reaction is alkaline. In all cases a history of a definite hæmoptysis should be treated seriously and as soon as possible further investigations should be carried out to determine its cause. In some cases, however, a cause cannot be found.

Treatment. In cases of pulmonary tuberculosis the patient should be propped up in bed in a semi-recumbent position, and if it is known from which lung the bleeding is coming, he should be inclined slightly to that side. This helps to prevent the blood being aspirated into the healthy lung and carrying tuberculous infection there. If the bleeding is severe, or if the patient cannot be calmed, a hypodermic injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) should be given immediately. It is not wise to sit the patient up, withhold morphine and encourage the patient "to cough the blood up." Such treatment

may result in death. The patient must keep still and not do anything for himself. The chest may be auscultated, but percussion must not be performed. If the bleeding persists, the morphine may be repeated, but not more than a total of 1 gr. (60 mg.) should be given in 24 hours. Bandages applied to the thighs, with sufficient pressure to obstruct the venous but not the arterial circulation, sometimes help to stop the hæmorrhage. They should be kept on for half an hour, and then can be applied to the upper arms for another half-hour. If the bleeding is very severe and threatening life, an endeavour should be made to collapse the affected lung by means of an artificial pneumothorax. Usually about 500 to 800 ml. of air must be introduced into the pleural cavity to check the hæmorrhage. If this is not possible owing to pleural adhesions, artificial pneumoperitoneum is an alternative measure which has met with success. It has the advantage that it is not necessary to know from which lung the bleeding is coming. 700 to 800 ml. of air are usually required to stop the bleeding, refills being made twice in the first week and subsequently once a week for 6 to 8 weeks. Cough should be allayed by a sedative linctus. Alcohol, ergot and digitalis should not be used. All food should be taken cold, but it need not necessarily be fluid, thin bread and butter, jellies, cold fish and cold chicken being allowed, and a saline aperient of mag. sulph. 120 gr. (8 G.) should be given. Vitamin C deficiency can be diagnosed by studying the concentration of ascorbic acid in the urine before and after the administration of test doses of ascorbic acid. If there is deficiency of vitamin C, ascorbic acid tab. 50 mg., 2 tabs. t.i.d. should be given. If no response is obtained and the capillary resistance is lowered, vitamin P should be administered, as Permudin tab. 0.25 G., 4 tabs. daily. If the hæmoptysis is associated with hypoprothrombinæmia vitamin K should be prescribed as Synkavit, one tab., 10 mg. t.i.d. by mouth, together with Bilein 5 gr. (0.3 G.) capsule, 2 t.i.d. by mouth, if there is jaundice. Alternatively, Synkavit, 10 mg., is injected intravenously or intramuscularly for 3 or 4 days.

Abscess of the Lungs

Definition. A localised purulent necrotising infection of the lungs.

Etiology. The abscess is caused by infection with pyogenic organisms, such as streptococci, staphylococci, pneumococci, spirochaetes or anaerobes. Spirochaetes are almost always present in the pus of inhalation abscesses. The varieties of lung abscess may be classified as follows: 1. *Aspiration*. This is due to inhalation of septic material, as after tonsillectomy or other operations on the naso-pharynx. Vomited material may be inhaled under anaesthesia. A quinsy may rupture and the contents be inhaled during sleep. About one-third of all lung abscesses are of this inhalation type. 2. *Bronchogenic*. This is associated with foreign bodies in the bronchi, tumours, especially carcinoma, bronchial stenosis and bronchitis. Twenty-five per cent. of all lung abscesses are associated with bronchial carcinoma. 3. *Hæmatogenous*. The infecting organism is carried to the lungs in the blood stream.

Staphylococcal septicæmia is a frequent cause in children. 4. *Necrotising pneumonia*. This may occur after bronchopneumonia or lobar pneumonia, usually due to a *Klebsiella pneumoniae* (Friedländer's bacillus) infection which may be combined with staphylococci. Small multiple abscesses form which may become chronic. 5. *Infected cysts*. Bronchogenic cysts are often infected and may lead to abscess formation. 6. *Eosinophilic*. Due to a filarial infection. 7. *Transdiaphragmatic*. Subphrenic abscess or amœbic abscess of the liver may give rise to pulmonary abscess formation. 8. *Transthoracic*. Due to a wound. 9. *Mediastinal*. Suppuration in the mediastinum secondary to carcinoma of the œsophagus, or suppuration in the bronchial lymph nodes may result in pulmonary abscess. A lung hæmatoma may also suppurate. The amœbic pulmonary abscess is described separately.

Pathology. The inhalation abscess is usually in the right lung, especially in the axillary and posterior sub-apical segments of the upper lobe, less frequently in the apical segment of the lower lobe. Embolic abscesses may be multiple, and often they are close to the pleura. The abscess may be encapsulated and closed, or in connection with a bronchus.

Clinical Findings. Since the use of antibiotics the incidence of lung abscess has been considerably reduced. A typical example of inhalation abscess is as follows: A day or so after the inhalation of infected material the temperature rises. After a few days the patient notices that his breath is offensive after cough. The temperature then rises higher, and the patient is acutely ill.

On Examination: In the early stages a small area of dulness, with diminished tactile fremitus, weak breath sounds and a few râles, is detected in one lung. Unless the abscess is in connection with a bronchus there is no purulent sputum. The temperature, and pulse and respiration rates are all raised. If the abscess ruptures into a bronchus, offensive purulent sputum is produced. This may measure about 14 fl. oz. (420 ml.) or more in the 24 hours. With the appearance of the pus the temperature usually falls, and the general condition of the patient is ameliorated. The blood shows a leucocytosis of about 12,000 to 15,000 per c.mm. The X-rays reveal a shadow in the lung, at first homogeneous, but after rupture into a bronchus a cavity with a fluid level may be seen when the patient is in the erect position. This may only be visible in a lateral radiogram. The X-ray appearance of staphylococcal abscesses has been described on p. 155.

Differential Diagnosis. In the early stages a pulmonary abscess may be mistaken for bronchopneumonia or an encysted interlobar empyema. After rupture has occurred, the possibility of bronchiectasis must be considered. The history of the case, and the clinical and X-ray findings usually render the diagnosis clear. It should always be remembered that a lung abscess may be associated with a bronchial carcinoma, the former being the prominent feature. The diagnosis is generally established by bronchoscopy.

Course and Complications. In some cases the patient coughs up the contents of the abscess, the temperature rapidly falls to normal,

and a spontaneous cure is effected. In untreated cases the expectoration is continuously purulent, and the temperature falls, with periodical rises as retention of secretion occurs. The suppurative process is slowly continuous; recurrent hæmoptysis, and eventually bronchiectasis may result. The infection may be very acute, or the patient's resistance very low, and the lung then becomes gangrenous. Metastatic foci may form elsewhere, such as an abscess in the brain.

Prognosis. This has been much improved by antibiotic treatment.

Treatment. *Prophylactic:* Acute pulmonary infections should be adequately treated by antibiotics. Intramuscular injections of 1 million units (600 mg.) of benzylpenicillin should be given daily for a week after operations on the nose and throat. *Curative:* One million units of benzylpenicillin should be injected intramuscularly every 12 hours, combined with 0.5 G. streptomycin every 6 hours. If the infecting organism is a staphylococcus cloxacillin (Orbenin) should be given (see p. 157). Postural drainage should be used if the abscess is in a position to respond to such treatment and is in communication with a bronchus, but this should be postponed until the acute stage is over. If a cure is not effected in 2 or 3 weeks further measures will be required. An attempt may be made to empty the abscess by passing a bronchoscope under local anaesthesia. The operation of choice is now usually lobectomy, rather than drainage through the chest wall, especially in chronic abscess.

Gangrene of the Lungs

Etiology. Gangrene of the lungs is now so rare, owing to the early diagnosis and efficient treatment of the predisposing lung conditions, that it hardly merits a separate description. The sputum is horribly offensive and contains portions of disintegrated lung tissue and numerous aerobic and anaerobic organisms. The patient is desperately ill with severe sweats and high fever, and the few cases I have seen have succumbed to the infection.

Hydatid Disease of the Lungs

Etiology. The disease is due to infection with the ovum of the *Echinococcus granulosus* (*Tænia echinococcus*).

Pathology. The cyst usually forms in a lower lobe of the lungs, frequently on the right side. It is generally solitary, and surrounded by a fibrous capsule. It may rupture into a bronchus, or into the pleura, pericardium, aorta, pulmonary veins or through the diaphragm. The cyst varies in size, up to about 4 or 5 inches (10 or 12.5 cm.) in diameter. In some instances its contents inspissate.

Clinical Findings. The patient may give a history of residence in some country such as Australia, where hydatid disease is comparatively common. He may not notice any alteration in his health, and the cyst is discovered by X-ray examination. In other cases the early symptoms are those of bronchitis, or of an intra-thoracic tumour. Thus there may be cough with expectoration, or progressive dyspnoea.

On Examination: The physical signs in the lungs may be very

slight, or a definite area of dulness may be detected in one lung, with weak breath sounds and diminished voice conduction. As the cyst enlarges the mediastinal contents are displaced towards the opposite side. The blood may show an eosinophilia up to 6 or 8%, and the intradermal Casoni test (see p. 83) is usually positive. If the cyst ruptures into a bronchus, hooklets may be found in the sputum.

Differential Diagnosis. The X-ray findings are fairly characteristic, the cystic shadow having a defined margin especially in the lateral view. Other conditions, such as a dermoid cyst or a simple pulmonary tumour, may cause difficulties. The blood and cutaneous tests for hydatid are useful for confirmatory evidence.

Course and Complications. A progressive enlargement of the cyst will give rise to increasing dyspnoea, whereas shrinking and inspissation are followed by a disappearance of all symptoms. Rupture into a bronchus may be followed by a pulmonary abscess; rupture into the pleura by shock and urticaria; and rupture into the pericardium, aorta or a pulmonary vein may cause sudden death.

Treatment. The cyst should not be aspirated. Thoracotomy by a skilled surgeon will often enable the cyst to be removed.

Dermoid Cysts of the Lungs

Clinical Findings. There are usually no symptoms until the cyst enlarges sufficiently to cause pressure effects. The patient may then complain of cough, expectoration, shortness of breath or of pain in the chest. Hairs may be seen in the sputum, and the presence of the cyst is revealed by X-ray examination. Instead of rupturing into the lung the dermoid may enlarge considerably, compressing the lung into a thin layer. The physical signs are then those of pleural effusion. On aspiration through the chest wall the diagnosis may be established by finding hairs in the pultaceous contents of the cyst.

Treatment. If causing pressure effects, an attempt at removal should be made by a skilled chest surgeon.

Congenital Cysts of the Lungs

Etiology. Congenital cysts are uncommon and are probably formed by a dilatation of the atria of the lungs, as no alveoli are present.

Pathology. In children or adults single or multiple cysts of varying size may be found, containing air or fluid. The fluid contents may be watery, mucoid or purulent. Congenital cysts are classified as: 1. The large balloon cyst which may completely compress the lung in an infant or young child. 2. The solitary cyst occupying up to half the lung field. 3. Multiple medium-sized cysts often seen near the lung root. 4. Multiple small cysts resembling bronchiectasis. They may be distinguished microscopically from bronchiectasis, for with congenital cysts the cartilage, muscle, elastic tissue and glands are irregularly distributed in the supporting tissues, the lining epithelium often remaining intact. With bronchiectasis the epithelium is destroyed, whereas the structures in the wall maintain their normal position.

Clinical Findings. An infant may be still-born and at autopsy the lungs are full of small cysts. In an infant or young child sudden dyspnoea may result from distension of a large cyst. Congenital cystic disease in adults may give rise to recurring attacks of dyspnoea, cyanosis and hæmoptysis. When infection occurs there is loss of weight, irregular fever, cough, offensive sputum and clubbing of the fingers. This may be followed by lung abscess, bronchiectasis, empyema or cerebral abscess. A cyst may rupture and cause a simple or benign spontaneous pneumothorax.

Differential Diagnosis. A single air-containing cyst may be erroneously diagnosed as a cavity due to pulmonary tuberculosis or as a pneumothorax. When infected, the clinical findings resemble those of lung abscess or bronchiectasis.

Treatment. This varies with the type of cyst. Pressure symptoms in a large balloon cyst must be immediately relieved by the insertion of a needle, followed later by pneumonectomy or by removal of the cyst if it is pedunculated. Radical cure of unilateral infected cysts may be effected by lobectomy or pneumonectomy.

Paragonimiasis

(*Pulmonary Distomiasis. Lung Fluke Disease*)

Etiology. The causative organism is a trematode, the *Paragonimus westermani* or *Distoma ringieri*. Infection in man occurs by drinking infected water, by bathing in it, or by eating infected crabs. The disease is endemic in Japan, Formosa, Korea, China and the Philippines.

Pathology. The trematode makes burrows in the lung.

Clinical Findings. The patient complains of recurrent hæmoptysis, often related to exercise. The diagnosis is established by finding the ova in the sputum.

Treatment. *Prophylactic:* In infected areas all drinking water must be boiled, bathing should be forbidden and crabs must not be eaten.

Curative: This is as for bilharziasis.

THE PLEURA

Acute Dry Pleurisy

(*Fibrinous or Plastic Pleurisy*)

Definition. Inflammation of the pleura, not accompanied by a fluid exudate.

Etiology. Primary cases may be due to a rheumatic infection, following exposure to cold. Pleurisy is often secondary to a tuberculous focus in the lungs, to pneumonia, pulmonary infarct, bronchiectasis, a neoplasm of the lungs, or to injury of the chest wall and at times to pulmonary actinomycosis.

Pathology. The inflammation may be localised or diffuse, both layers of the pleura are usually involved, a sticky exudate of lymph and fibrin being found. The pleurisy may be localised to an interlobar septum, or to the diaphragmatic pleura.

Clinical Findings. In the primary cases, and in those associated with tuberculosis the patient is often a young adult who says that he was suddenly seized with a pain in the side resembling a "stitch." Any attempt at taking a deep breath or coughing intensifies the pain. It should be remembered that in some cases there may be no pain, although an extensive pleural rub is present.

On Examination: The temperature is usually a little raised, 99° or 100° F. (37.2° or 37.8° C.). The respiration rate is also somewhat above the normal, but the breathing is shallow. The patient may prefer to lie in bed on his back or on the sound side, owing to local tenderness over the affected area.

The chest. Inspection: The movement may be slightly diminished on the affected side. **Palpation:** Often there is local tenderness at the site of the pain. Friction fremitus may be felt. **Percussion:** The resonance is normal, or slightly diminished. **Auscultation:** There is weak air entry over the area of the pleurisy. A leathery or creaking rub may be heard at the end of inspiration or beginning of expiration, or fine pleural crepitations at the end of inspiration. These are constant after cough, helping to differentiate them from pulmonary râles which often disappear after cough. Vocal resonance may be slightly diminished over the affected area.

In diaphragmatic pleurisy the pain is often referred to the tip of the corresponding shoulder or to the shoulder joint (the reflex is through the phrenic nerve to the 4th cervical nerve root), or the symptoms may be abdominal. In the latter case a tender area can be found in the subcostal plane, about 2 inches (5 cm.) from the mid-line (*le bouton de Guéneau de Mussey*). There is usually weak air entry over the corresponding lower lobe of the lung. In interlobar pleurisy, the inflammation may be localised to the septum between the right upper and middle lobes. The pain is then felt in the region of the fourth right costal cartilage, and fine crepitations may be audible at this level. Often the condition is only revealed by X-ray examination.

Differential Diagnosis. Other causes of pain in the chest must be considered, such as myalgia or fibrositis of the intercostal muscles or membranes (pleurodynia), Bornholm disease, intercostal neuralgia or neuritis, Tietze's syndrome, characterised by pain and swelling of a costal cartilage, the cause of which is unknown, periostitis of a rib, the initial pain of herpes zoster, and pain referred from the heart or abdomen. The physical signs of dry pleurisy, enumerated above, are very characteristic. In intercostal myalgia, although the pain is intensified by deep breathing, no pleural signs are found. In intercostal neuritis or neuralgia the pain follows the nerve path, and localised tender spots are present, especially at the back (posterior primary division), in the mid-axilla (lateral cutaneous branch) and at the chondro-sternal junction (anterior cutaneous branch). The appearance of the typical eruption establishes the diagnosis of herpes. Rib periostitis may be shown by X-ray examination. Pain due to cardiac or gastric causes is often related to effort or to digestion.

Course and Complications. In simple cases the pain usually lasts

for about a week, but fluid may rapidly form, and, by separating the inflamed surfaces, cause the pain to disappear. In other cases the pain of dry pleurisy is rapidly followed by the symptoms and signs of lobar pneumonia, or it may be the initial symptom of a pulmonary neoplasm or of tuberculosis. An extensive plastic pleurisy may pass on to pleurogenous fibrosis of the lungs.

Prognosis. This depends largely upon the cause. The possibility of pulmonary tuberculosis or of a neoplasm should always be borne in mind.

Treatment. The patient must be kept in bed until the temperature is normal. The pain may sometimes be relieved by the application of liq. iodi mitis or cataplasma kaolini to the affected side. If this is unsuccessful the side should be strapped from base to apex, in a position of full expiration. The useless dry cough can be checked by a sedative linctus. To secure sleep some drug such as aspirin 5 to 10 gr. (0.3 to 0.6 G.) may be given at night. The diet during the febrile period should be fluid or semi-solid, and the bowels should be opened daily. When the temperature has fallen the chest should be X-rayed to see if there is any evidence of underlying pulmonary disease. If a tuberculous focus is discovered, the treatment is as for an early case of pulmonary tuberculosis. Apart from this, gentle breathing exercises should be encouraged during convalescence, to expand the lung, increase the circulation and prevent the formation of pulmonary fibrosis.

Chronic Dry Pleurisy

Chronic thickening of the pleura, sometimes with calcified plaques, may be found in association with pulmonary tuberculosis, in artificial pneumothorax or pleural effusions of some duration, after an empyema, and in polyserositis.

Pleural Effusion

The following varieties are described: 1. Clear effusions, of which there are two varieties, pleurisy with effusion (serothorax), and a pleural transudate (hydrothorax). 2. Purulent effusion, an empyema (pyothorax). 3. Hæmorrhagic effusions, such as hæmothorax, hæmoserothorax, and hæmohydrothorax. 4. Milky effusions, such as chylothorax, pseudochylothorax, and chyloform effusions.

Pleurisy with Effusion

(Sero-fibrinous pleurisy. Serothorax)

Definition. An inflammatory serous pleural exudate.

Etiology. The most important cause is a tuberculous focus in the lungs or pleura. Some cases may be due to rheumatism, or occur as a complication of septicæmia or typhoid fever. Less commonly the effusion is associated with inflammatory pulmonary lesions such as pneumonia, virus pneumonia and bronchopneumonia, with a pulmonary infarct, or with malignant disease of the lungs, pleura, mediastinum or ribs. It may also be met with as a complication of lesions of the peri-

cardium or abdomen, or as a manifestation of polyserositis. Artificial pneumothorax was complicated by a serous effusion in about 50% of cases.

Pathology. A plastic pleurisy is followed by the output of a clear yellow exudate. The specific gravity of the fluid is between 1.010 and 1.018. The reaction is alkaline, and protein (albumin, globulin and fibrinogen) is present to the extent of 4% or over. The fluid usually clots on standing. Microscopically polymorphonuclear cells, lymphocytes and a few red cells are seen, and occasionally eosinophils predominate. In one case with combined abdominal tuberculosis and a tuberculous pleural effusion the fluid showed 80% and the blood 14% of eosinophils. A few pleural endothelial cells may also be seen. The exudate is often sterile, but tubercle bacilli may be found, or, if the exudate is injected into a guinea-pig, it may cause the animal's death from tuberculosis. Lymphocytosis is suggestive of a tuberculous infection. In other cases the pneumococcus or *Salmonella typhi* may be found. The amount of fluid varies from a few ounces to over 2 pints (1.2 litre).

Clinical Findings. The effusion may arise insidiously or follow an attack of acute dry pleurisy, or occur as a complication of one of the conditions mentioned above. The symptoms vary with the mode of onset, and the patient may complain of pain or of dyspnoea. The results produced by the effusion depend largely upon the amount of fluid present.

On Examination : In an average case there is fever of 101° F. (38.3° C.) or over, the pulse is frequent, 100 or more, and the respiration rate is above normal. The patient appears distressed on slight exertion, and there is some cyanosis. He tends to lie on the affected side or may require to be propped up. The chest. Inspection : There is diminished movement on the affected side. The shadow of the diaphragmatic movement, as seen on the chest wall when the patient breathes, is not visible on the affected side (Litten's sign). The cardiac impulse may be seen displaced away from the side of the effusion. Palpation : There is diminished expansion on the affected side. Tactile fremitus is usually absent over the effusion. The cardiac apex is moved away from the side of the fluid, and in a left-sided effusion cardiac pulsation may be felt to the right of the sternum. Percussion : There is stony dullness over the effusion, above the level of the fluid a high-pitched note may be elicited (*skodaic resonance*) due to compression of the lung. The upper level of the effusion is shown by X-ray investigations to be horizontal, and not curved upwards in the axilla as previously described by Ellis and Damoiseau. The level of the upper border of the fluid may also vary with change of position of the patient. A triangular area of dullness may be found on the opposite side at the back, owing to the fluid forming a mediastinal bulge (Grocco's triangle). The apex of this triangle is on top, near the spine, at the level of the upper border of the effusion. Auscultation : The breath sounds over the fluid may be absent, very weak, or bronchial in character if the lung is collapsed and the bronchi remain patent. The air entry is usually feeble above the fluid, whereas over the opposite lung the breath sounds are loud and harsh. Some

scattered rhonchi may be heard above the fluid, and a few râles at the opposite base. Usually there are no adventitious sounds over the dull area, but at times some coarse râles are audible. A pleural friction rub may be heard just above the upper fluid level. Vocal resonance is usually absent over the fluid, but near its upper level the conducted voice sound has a nasal or bleating character (ægophony). Whispering pectoriloquy and bronchophony are occasionally present over a pleural effusion. A large pleural effusion may cause a downward displacement of either the liver or the spleen.

Differential Diagnosis. The nature of the fluid in the chest can only be determined by exploratory puncture. The diagnosis of the presence of a pleural effusion is often a matter of great difficulty, especially if the fluid is of small volume or loculated by pleural adhesions. The most reliable indications of fluid are the triad of signs, stony dullness, absence of tactile fremitus, and absence of adventitious sounds. Cardiac displacement is not always present. The breath sounds are so variable that no reliance can be placed on them. A pleural effusion must be differentiated from the following conditions: Thickened pleura and fibrosis of lung, consolidation of the lung, and pericardial effusion. With a thickened pleura and fibroid lung, the dullness is not of such a stony character, the chest wall is often flattened and the heart may be displaced towards the affected side. Adventitious sounds, such as fibroid râles, are often heard over the affected lobe. In pulmonary consolidation the note also is not so stony, vocal fremitus is increased, and râles are usually audible. There is also no cardiac displacement. In pericardial effusion, the dullness has a peculiar shape (see p. 220), and the signs at the left base behind are those of consolidation (see p. 220). In all cases of doubt, especially in a localised interlobar, mediastinal or diaphragmatic effusion, an X-ray examination is of great value, and should be obtained, if possible, before any exploratory puncture of the chest is made. It has been stated that blind punch biopsy of the parietal pleura can establish the diagnosis in about 80% of tuberculous and 60% of malignant effusions.

Course and Complications. A small pleural effusion is usually absorbed spontaneously in 2 to 3 weeks, with some resultant pleural thickening, adhesions, or calcification. The compressed lung re-expands and very little abnormality can be detected subsequently. In other cases the lower portion of the lung does not completely expand, is congested, and fibrosis of the lung ensues. Acute cedema of the lungs is a rare complication during the early stage of the disease. A large effusion often will not absorb until a certain amount has been removed by aspiration. In other cases after aspiration the effusion recurs repeatedly, causing little constitutional or mechanical disturbance. A thick layer of fibrin may be deposited on the pleura, constituting a fibrothorax.

Prognosis. The immediate prognosis is good, but in about 80% of cases of pleural effusion forming between the ages of 15 and 40 years pulmonary tuberculosis develops within 5 years. Less frequently bronchiectasis ensues on fibrosis of the lung.

Treatment. The patient should be kept in bed as long as the

temperature is raised, and, if practicable, until the effusion is absorbed. The amount of fluid ingested should be limited to 2 pints (1.2 litre) a day, and in obstinate cases a salt-poor diet (see p. 243) may be given. The affected part of the chest should be painted every other day with liq. iodi mit. A syringe-full of fluid should be removed from the pleura and examined chemically, cytologically and bacteriologically. It is not advisable to aspirate all pleural effusions as a routine procedure. Unless there is good evidence that the effusion is not due to tuberculosis a course of streptomycin, I.N.A.H. and/or P.A.S. is advisable (see p. 169).

Hydrothorax

Definition. A transudate into the pleural space.

Etiology. The two main causes of hydrothorax are heart failure and renal disease. More rarely it is associated with severe anæmia, famine œdema or deficiency of the vitamin B complex, or with thrombosis of the azygos veins, or pressure upon them by a mediastinal growth or by mediastinal lymph node enlargement due to Hodgkin's disease or leukæmia. Meigs' syndrome, first described by Cullingworth in London in 1879 and later in America by Meigs in 1934, is characterised by an ovarian fibroma with ascites and hydrothorax. It is suggested that the hydrothorax results from mechanical obstruction to the venous return within the abdomen, or that the fluid passes by lymphatics through the diaphragm to the pleura, or through a persistent pleuro-peritoneal canal. Hydrothorax and ascites occasionally occur associated with cirrhosis of the liver.

Pathology. The fluid transudes either as the result of venous stasis or owing to changes in the blood and tissues associated with renal disease. The transudate is pale yellow, the specific gravity is lower than 1.010, and a small quantity of protein (albumin and globulin) is present. This is less than 3%. It does not clot on standing. Microscopically only a few endothelial cells are present and there are no organisms. The transudate may be bilateral.

Clinical Findings. The history is that of the antecedent condition, usually cardiac or renal disease. An increase of dyspnoea suggests fluid in the pleura, the physical signs of which have been described above. Cardiac displacement is not generally marked. There is no disturbance of temperature, and no preliminary stage of dry pleurisy is noted. Œdema is often present elsewhere, in the legs, hands or back. Cases of Meigs' syndrome are likely to be considered to be malignant and inoperable, and so it is important that a correct diagnosis is made. The pleural effusion is large, unilateral, generally on the right side, and displaces the mediastinum. The ovarian fibroma can usually be removed with subsequent cure of the condition.

Course and Complications. The course depends largely upon the results of the treatment employed for the underlying cause.

Prognosis. This is often grave, as in cardiac disease the transudate is an indication of circulatory failure, and in renal disease it is an expression of defective elimination.

Treatment. The fluid should be aspirated if it is causing distress,

and the appropriate treatment given for the œdema of cardiac or renal disease, or for vitamin B deficiency.

Empyema (*Pyothorax*)

Definition. Pus in the pleural cavity.

Etiology. The incidence of empyema has been much lowered by the use of sulphonamides and antibiotics and it is now a comparatively rare disease. Empyema was formerly most often a complication of lobar pneumonia or of bronchopneumonia. It may be syn-pneumonic or meta-pneumonic, according to whether it develops during the acute febrile stage of pneumonia or as a complication after the temperature has fallen to normal. Other causes are pulmonary tuberculosis, bronchiectasis, abscess or gangrene of the lung, mediastinal abscess, carcinoma of the œsophagus, pericarditis, penetrating wounds of the chest, subphrenic abscess, septicæmia and pyremia. Rarely it appears to develop as a primary condition. The causative organisms include the *Streptococcus pneumoniae* (pneumococcus), streptococci, the *Mycobacterium tuberculosis*, the *E. coli*, the *Haemophilus influenzae*, the *Klebsiella pneumoniae* (Friedländer's bacillus), *Salmonella typhi*, staphylococci and varieties of streptothrix. A sterile purulent effusion is met with in tuberculous pyothorax, and in some acute cases, for a day or so after the rupture of a lung abscess.

Pathology. The pleura becomes thickened, and the lung collapsed and fibrosed in long-standing cases. The pleural space becomes an abscess cavity, and the walls a pyogenic membrane, which is often resistant to antibiotic treatment, necessitating excision. The fluid may be odourless or very offensive, it may be thin or thick, yellowish, greenish or brown. Large fibrinous flakes are often present in pneumococcal infections, whereas in a streptococcal empyema the fluid is often thin. The specific gravity is usually over 1.030, and numerous disintegrating pus cells are present. The fluid may be free, or loculated at the base, apex, on the mediastinal surface or in an interlobar fissure. It may track through the chest wall, into the lungs or pericardium, or through the diaphragm.

Clinical Findings. Empyema is chiefly a disease of children and young adults, although it may occur at any age. In a typical meta-pneumonic case, after an attack of lobar pneumonia, the temperature, which has fallen to normal for a few days, gradually rises again by irregular stages. The condition of the patient deteriorates, the appetite fails and shivering or sweating attacks may occur. There may be an actual rigor. As the effusion increases in size the toxæmic symptoms are more marked, the pulse and respiration rates increase and there is dyspnoea.

On Examination: Often there are no special symptoms. The physical signs of pleural effusion may be found, but they are often localised to a small area. In addition, the special features met with in empyema are as follows: The patient is often pale and has a toxæmic appearance. There may be bulging of the intercostal spaces on the

affected side, or œdema of the chest wall or corresponding arm. Pulsation may be seen in left-sided cases, usually near the apex of the heart (*empyema necessitatis*), when the empyema tracks through the intercostal muscles. Clubbing of the fingers may rapidly appear. The breath or sputum is offensive if the empyema is interlobar and communicates with a bronchus. There is usually a leucocytosis of between 15,000 and 20,000 per c.mm. X-ray examination is of value in locating the fluid, and the exploratory needle reveals the presence of pus.

Differential Diagnosis. It is easy to overlook an empyema, especially when the onset is insidious, as so often is the case in pneumonia. It should always be suspected if the temperature rises again after it has fallen to normal, unless this rise can be accounted for by some other complication such as spread of the disease, or the development of pericarditis. In all cases of doubt an exploratory puncture should be made, but in some cases the pus is thick and will only pass through a wide bore needle. An apical empyema is a source of difficulty; it may be mistaken for a pulmonary neoplasm, but in empyema the dulness does not extend across the mid-sternal line, as it may do with a new growth. An interlobar empyema is to be suspected, when localised signs of fluid are discovered along the line of an interlobar septum, or if the breath is offensive on coughing. The X-rays are of inestimable value in the diagnosis. The following conditions also must be excluded in certain cases: Unresolved pneumonia and fibrosis of the lung, tuberculosis or a growth of the lung, a rib abscess, an aneurysm, and a subphrenic abscess. In unresolved pneumonia and pulmonary fibrosis the heart is not displaced away from the affected side, and usually râles are heard over the dull area, and tactile fremitus is present. In doubtful cases exploratory puncture should be made. A rib abscess may be mistaken for a pointing empyema, or an aneurysm for a pulsating empyema. The X-ray examination is invaluable in such cases. In subphrenic abscess help is obtained from the history of the antecedent condition, and the X-ray examination, which may reveal the situation of the diaphragm, raised in a subphrenic abscess and depressed in an empyema. There is usually no lateral cardiac displacement with a subphrenic abscess. If an exploratory needle is inserted through a lower intercostal space and passed downwards until the pus is located, the needle will move with respiration in a subphrenic collection, as it must pierce the diaphragm.

Course and Complications. Unless the empyema is effectively treated, the patient usually becomes more severely ill and will eventually die from heart failure, pyæmia, amyloid disease or cerebral abscess. In rare instances the virulence of the empyema abates and a sterile empyema results, with calcification of the pleura. Further, an empyema may develop on the opposite side, or the pus may track through the chest wall, into the mediastinum, pericardium, lung, or into the neck or abdomen. If an empyema ruptures into a bronchus it may result in spontaneous cure, or form a bronchial fistula, or cause death by suffocation. Other complications include abscess or gangrene of the lungs, bronchiectasis, pulmonary osteo-arthritis, pyæmia and abscess in

skeletal muscles. Permanent pleural thickening or fibrothorax usually remains as a sequela of an empyema.

Prognosis. Empyema is a serious condition but the prognosis is naturally improved by early diagnosis and efficient treatment. Unless adequately treated there is a danger of the empyema becoming chronic.

Treatment. In all cases of doubt the chest should be explored. In loculated or interlobar empyema it may be necessary to perform several punctures under a general anæsthetic, the surgeon being then prepared to proceed to evacuate the pus if it is located. Penicillin should be administered intrapleurally, following aspiration of the pleural fluid, in the treatment of empyema due to pneumococci, streptococci or staphylococci, but not in cases of *E. coli*. infection. The amount injected is usually 1 million units (600 mg.) in 10 ml. sterile water. Three or four aspirations and instillations on alternate days generally suffice. A specimen of pus should be withdrawn the day after each aspiration to see if organisms still persist. For hæmolytic *Staphylococcus aureus* and *E. coli* infections chlortetracycline (Aureomycin) 100 mg. or chloramphenicol 250 mg. in 0.5% sterile saline solution should be introduced into the pleura instead of penicillin. Thoracotomy was formerly required to evacuate blood clot, fibrin and pus but the introduction into the pleural cavity of 200,000 units of streptokinase and 75,000 units of streptodornase may avoid this necessity. These substances cause lysis of the clots. There still remain some cases which require surgical drainage or more extensive operations on the lung and pleura. Local penicillin treatment after rib resection is often unsatisfactory, and benzylpenicillin is then best given by intramuscular injections of 1 million units (600 mg.) every 12 hours. After-treatment consists in the use of suitable inspiratory breathing exercises to expand the lung. A tuberculous empyema should never be treated at first by rib resection, but the fluid should be repeatedly aspirated, injecting 1 G. of streptomycin into the pleural cavity after each aspiration. A course of streptomycin should also be given by intramuscular injections and I.N.A.H. administered by mouth. In some cases thoracoplasty or extrapleural pneumonectomy is necessary.

Hæmothorax

Definition. Blood in the pleural cavity.

Etiology. Hæmothorax may result from wounds of the chest wall or the lungs, from blast of high explosives, from fractured ribs injuring the lung, from division of pleural adhesions, or from rupture of an aneurysm. Hæmorrhage into aberrant lung tissue may rupture into the pleura. It has also been recorded on the left side due to a strangulated diaphragmatic hernia containing omentum and gangrenous stomach.

Pathology. In gunshot wounds of the chest, the blood pours out into the pleural space and does not clot. The diaphragm is usually displaced upwards on the affected side, and the lung is collapsed. The hæmothorax may become infected with streptococci or with anaerobes. In other cases death rapidly ensues and the blood is clotted.

Clinical Findings. The patient who has had a penetrating wound of the chest usually gives a history of hæmoptysis following directly on the wound. He then complains of pain in the chest, cough and dyspnoea.

On Examination : The signs of a pleural effusion are found. If the fluid is sterile, there is little or no pyrexia, but if, as is often the case, it is infected, a high temperature is registered. In addition, as air is often present in the pleural cavity together with blood (traumatic hæmopneumothorax), the signs of fluid and air may also be detected.

Differential Diagnosis. The nature of the fluid is determined by exploratory puncture.

Course and Complications. The course is usually that of an uncomplicated pleural effusion, with gradual absorption of the fluid. If the blood becomes infected the temperature suddenly rises to 102° F. (38.9° C.) or higher, and the patient becomes desperately ill.

Prognosis. This is usually good in cases due to wounds. If the hæmothorax is due to rupture of an aneurysm, death occurs in a few minutes.

Treatment. Aspiration of the fluid aids absorption, but this is not required in small effusions. In all cases a course of intramuscular penicillin should be given. If the fluid is infected the treatment is the same as for empyema.

Hæmoserotherorax

Definition. A serous pleural exudate, containing blood.

Etiology. Hæmoserotherorax may be met with in association with new growths of the lung, pleura or mediastinum, with pulmonary or pleural tuberculosis, or after previous aspirations of a serotherorax. It usually follows pneumonectomy. At times it is a manifestation of scurvy or a complication of cirrhosis of the liver, scarlet fever, small-pox, purpura or lobar pneumonia.

No special description of the clinical findings is called for, as they resemble those of sero-fibrinous pleurisy. The finding of blood in the pleural fluid should always be regarded as a very suspicious indication of an intra-thoracic new growth.

Hæmohydrothorax

Definition. A pleural transudate containing blood.

Etiology. Hæmohydrothorax is most usually associated with heart failure. The clinical findings are those of hydrothorax.

Chylothorax

Definition. A pleural effusion of chyle or of fluid containing chyle.

Etiology. Chylothorax results from injury of, or obstruction to, the thoracic duct. These may be due to trauma, erosion by a growth, pressure of a growth or of enlarged mediastinal lymph nodes, or to internal blockage by a parasite, such as the *Wucheria bancrofti*.

Pathology. The fluid is milky and contains fat. On standing, the fat forms a layer on top of the fluid.

Clinical Findings. No special description is called for. The nature of the fluid is discovered by thoracic puncture. The fluid should not be aspirated unless causing cardiac embarrassment or dyspnoea.

Pseudochylothorax

Definition. An opalescent pleural effusion, which does not contain fat globules.

Etiology. Pseudochylothorax may be associated with chronic pulmonary tuberculosis, malignant disease of the lungs or pleura, and chronic disease of the heart or kidneys.

Pathology. The opalescence of the fluid may be caused by the presence of lecithin-globulin, calcium phosphate, cholesterin or filariæ. On standing, a deposit forms, which, in the case of cholesterin effusions, is seen as delicate silvery flakes.

Clinical Findings. The signs are those of a pleural effusion. The nature of the fluid is determined by removing a sample. Aspiration is rarely required.

Chyliform Effusions

Definition. A pleural effusion containing fat globules but no chyle.

Etiology. Chyliform effusions may be associated with tuberculosis or malignant disease of the lungs or pleura.

Pathology. The fluid has a milky appearance, and remains turbid on standing. The fat globules are probably derived from degenerating leucocytes and endothelial cells.

Clinical Findings. A sample of fluid should be removed for diagnostic examination.

Pneumothorax

(including *Hydropneumothorax* and *Pyopneumothorax*)

Definition. Air or gas in the pleural cavity. Serous fluid (hydropneumothorax), or less often pus (pyopneumothorax), may also be present.

Etiology. The air or gas may be derived from various sources.

1. The lungs: Rupture of a tuberculous focus accounts for many cases. It may also complicate an artificial pneumothorax. Less frequently the pulmonary lesion, which causes pneumothorax by its rupture, is an abscess, gangrene, new growth, anthrasicosis, infarct or a hydatid cyst of the lungs, or the perforation is caused by rupture of an empyema into the lung, a fractured rib or an exploring needle. "Benign spontaneous pneumothorax," also called "pneumothorax in the apparently healthy," or "pneumothorax simplex" constitutes a special group of cases. Over 80% of the patients are males. It is probably due to the rupture of an emphysematous bulla or congenital cyst of the lungs. It may also occur in sub-aqua diving at depth if the breathing apparatus fails and the diver surfaces rapidly, holding his breath. 2. The exterior: The air may be introduced therapeutically, as in artificial pneumothorax, or accidentally, owing to a wound of the chest wall opening the pleura, or during aspiration

of a pleural effusion. 3. The mediastinum : The air may come from the œsophagus, due to rupture. This may be secondary to carcinoma, to corrosive poisons or to trauma from an œsophagoscope or bougie, or no cause may be found. It may also follow bronchoscopy. 4. The abdomen : Pneumoperitoneum induction may cause pneumothorax because of a congenital pleuro-peritoneal hiatus. Perforation of the stomach, duodenum or colon may lead to a subphrenic abscess, which tracks through the diaphragm into the pleura. A liver abscess may rupture into the lung. 5. The pleura : Anaerobic organisms may form gas in a pleural effusion.

Pathology. In perforation of the lung, the opening may remain patent, air passing in and out with respiration, or it may immediately seal over (closed pneumothorax), or it may form a valve, air entering the pleural cavity with each inspiration and being unable to leave it with expiration. This latter variety is known as suffocative pneumothorax. A bilateral pneumothorax may occur, due either to rupture of both lungs, or to the air escaping from one pneumothorax, through a minute opening into the opposite pleural cavity.

Clinical Findings. A pneumothorax may occur suddenly in a patient who is apparently in good health, or as a complication of an illness which confines him to bed. This illness is usually pulmonary tuberculosis. The onset may occur while the patient is walking along the street, or be associated with a cough or some muscular effort. There is typically a sudden severe pain in the chest, often in the mid-axilla, and a sensation of something snapping may be felt. The patient may immediately collapse or find great distress in breathing. The degree of distress depends upon the nature of the opening into the pleura, whether valve-like or otherwise, and also upon the presence or absence of pleural adhesions, which loculate the pneumothorax and prevent mediastinal displacement. In the latter case, the onset of the pneumothorax is often symptomless, and it is only discovered on a routine examination.

On Examination : With a diffuse pneumothorax the patient is usually propped up in bed, very distressed and short of breath. The chest. *Inspection :* There is diminished movement on the affected side. The cardiac impulse may be seen displaced towards the sound side. *Palpation :* Tactile fremitus is absent on the affected side. The cardiac impulse is felt displaced away from the side of the pneumothorax. *Percussion :* There is a hyperresonant note over the pneumothorax. If fluid is also present, the note is impaired at the base, and shifting dullness may be obtained when the chest is percussed with the patient at first erect and then reclining. The upper border of liver dullness may be obscured in right-sided cases. *Auscultation :* The breath sounds over the pneumothorax are weak, and may be of a metallic bronchial character. The coin sound is often heard. This can be elicited in a modified form by flicking the chest wall over the pneumothorax with the finger nail, while listening through the stethoscope. Harsh breath sounds are audible over the other lung. With a shallow, left-sided pneumothorax systolic clicks, which are audible both to the

patient and to the examiner, may be heard near the apex of the heart. Metallic râles or a splash (Hippocratic succussion) may be heard if fluid and air are present in the pleural space (hydropneumothorax). The pulse rate is usually about 120 and the respirations 20 to 30. The diagnosis is confirmed by removal of a small quantity of air by exploratory puncture. A small syringe is used containing a 2% solution of procaine. When the needle enters the pleural space, bubbles of air can be sucked back into the syringe. The X-ray examination will show a clear area due to the air, and a collapsed lung. If there is a hydropneumothorax the upper level of the fluid assumes a straight transverse line, when the patient is erect. The physical signs in a loculated pneumothorax may closely resemble those of a pulmonary cavity, and X-ray examination is of value in differentiating them.

Differential Diagnosis. There is usually no difficulty in the diagnosis of a complete spontaneous pneumothorax. A loculated pneumothorax may simulate a pulmonary cavity or an emphysematous bulla. Further, a loculated apical pneumothorax, occurring in a patient who has extensive fibroid tuberculosis of the opposite lung, may cause sudden severe dyspnoea, so that it is mistaken for asthma. A partial, left-sided pneumothorax may symptomatically closely resemble coronary disease. Careful exploratory puncture of the pleura, as described above, will demonstrate the presence of air. If a pneumothorax needle is now inserted, attached to a manometer, it can be shown that the air is in the pleural sac and not in the lung. In the former, the mean pressure is positive, whereas if the needle is in the lung, there is a respiratory excursion of pressure above and below the zero line, the mean pressure being zero. A loculated basal pneumothorax may closely simulate a perforated gastric or duodenal ulcer, but with a careful examination on the lines described above, the diagnosis can usually be made.

Course and Complications. The course of a spontaneous pneumothorax depends upon its cause and the nature of the opening. Further attacks may occur or even bilateral pneumothorax. The occurrence of an infected pleural effusion increases the gravity of the situation.

Prognosis. This is often grave, death may rapidly result from shock, or the air may gradually be absorbed. Bilateral cases are also of greater severity. In advanced cases of pulmonary tuberculosis a spontaneous pneumothorax usually ushers in the final scene, whereas in early cases, or in "simple pneumothorax" due to rupture of an emphysematous bulla, the outlook is usually good, although it recurs in about 20% of cases.

Treatment. A hypodermic injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) should be given immediately if the patient is in distress. If the pressure of air is causing dyspnoea and cardiac embarrassment, it must be reduced. This can best be done with the aid of a pneumothorax apparatus. If the needle is now kept in the pleural cavity for 5 or 10 minutes, it can be seen if the pressure is rising again. If this is occurring, it will be necessary either to remove air frequently or to keep in the pleura a needle, to which is attached a rubber tube connected by a T glass tube

both with a pneumothorax apparatus to record the intrapleural pressure, and with a tube, the distal end of which dips under a disinfectant fluid, such as 1/1,000 perchloride of mercury, in a bottle on the floor. A cannula with a blunt edge, and not a sharp-pointed needle, should be left in the chest, as there is a risk of penetration of the lung and death from hæmoptysis. Alternatively a rubber catheter, size 10 Jaques, can be inserted into the pleural cavity with the aid of a trocar and cannula. The catheter is strapped to the skin and connected to an underwater seal. If the lung fails to expand after 3 or 4 weeks an obliterative pleurisy may be induced by the injection of an irritant such as 5 ml. of 1% camphor in olive oil.

If a hydropneumothorax is present, aspiration of the fluid will reduce the intrapleural pressure and so relieve distress. A pyopneumothorax requires treatment as for empyema.

Spontaneous Hæmopneumothorax

This is a rare condition in which air and blood escape spontaneously into the pleural cavity. In some cases the cause is a ruptured emphysematous bulla or a torn pleural adhesion, in others no source of the bleeding or air leak is discovered at autopsy. The treatment is as for spontaneous pneumothorax, the blood also being aspirated from the pleural sac. Transfusion of whole blood may be required to combat the anæmia, and if the bleeding persists thoracotomy may be necessary.

New Growths of the Pleura

Simple tumours are rare. They include a fibroma, lipoma, and angioma.

Malignant growths may be primary, such as a mesothelioma, carcinoma and sarcoma; or secondary, such as a carcinoma, sarcoma or endometrioma.

Mesothelioma of the Pleura

Etiology. Exposure to asbestosis is considered an important factor in the cause of the disease.

Pathology. The growth spreads over the pleura, and may cause considerable thickening of both layers. It may also infiltrate the pericardium and heart, and extend through the diaphragm, the peritoneum being studded with minute nodules. The two layers of the pleura may be studded with nodular growths up to 2½ inches (5.25 cm.) in diameter without general pleural thickening. A blood-stained pleural effusion is often present. The cells are chiefly endothelial. They may be agminated in plaques or rosettes, and show budding and mitotic changes (Foulis cells).

Clinical Findings. The patient is usually an adult of middle age, who complains of progressive loss of strength, with cough and shortness of breath.

On Examination: The patient may be wasted, and signs of a pleural effusion are present. On exploring the chest it will be noticed that the

needle passes through a considerably thickened pleura. The fluid is usually blood-stained as described above. In some cases enlarged lymph nodes are found above the clavicles or in the axillæ, and subcutaneous nodules may be felt along the ribs. Air-replacement of the fluid and subsequent thoracoscopic examination are of value in establishing the diagnosis in an early case, when the area of growth can be visualised. The X-ray appearance of a localised pleural mesothelioma are shown in Fig. 14.

Course and Complications. The course is usually rapid. Complications include extension to other parts of the body, such as the heart and peritoneum.

Prognosis. Death usually occurs in 2 to 8 months from the date of diagnosis.

Treatment. This is usually only palliative. In some early cases surgical removal is possible. Dyspnoea can be relieved by aspiration of the fluid. Pain and cough can be treated only by sedatives, such as morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.)

Calcification of the Pleura

This may be demonstrated radiographically in certain long-standing cases of encysted empyema or following a serous pleural effusion or chronic hæmothorax.

THE MEDIASTINUM

Mediastinitis

Definition. Inflammation of the mediastinal connective tissue.

Etiology. Acute mediastinitis is usually secondary to acute inflammation of the lungs or pericardium, to rupture of the œsophagus, or to wounds of the chest wall. Syphilitic mediastinitis may cause obstruction of the superior vena cava.

Clinical Findings. The history and the examination of the patient usually suggest the primary cause. The patient may complain of acute pain under the sternum and in the interscapular region. If an abscess forms, it may cause mediastinal pressure, and it may point behind in the interscapular area.

Treatment. An abscess should be drained surgically.

Mediastinal Emphysema

Definition. Air in the mediastinal connective tissue spaces.

Etiology. Mediastinal emphysema may result from rupture of the trachea, bronchi, or œsophagus, or be secondary to acute interstitial emphysema of the lungs.

Clinical Findings. The symptoms of mediastinal emphysema are usually masked by those of the primary cause. The patient may complain of pain under the sternum, and, on examination, a hyper-resonant note is found over the sternum. The heart sounds are distant, and surgical emphysema may be detected in the neck.

HOSPITAL



FIG. 14. MESOTHELIOMA OF PLEURA.



FIG. 15. DIAPHRAGMATIC HERNIA OF TRANSVERSE COLON PROBABLY THROUGH THE FORAMEN OF MORGAGNI (BETWEEN STERNAL AND COSTAL PORTIONS OF DIAPHRAGM) INTO RIGHT SIDE OF CHEST. THE PRESENTING SYMPTOM WAS DYSPNOEA.

(a) Before operation. (b) After operation.

Treatment. There is no special treatment, apart from that required for the primary condition.

Enlarged Mediastinal Lymph Nodes

Etiology. The lymph nodes which lie in the posterior mediastinum may be enlarged from various causes such as : 1. Simple inflammation in whooping-cough, measles, glandular fever, bronchopneumonia, pneumonia, pneumokoniosis and influenza. 2. Granulomatous infection, in tuberculosis, sarcoidosis and syphilis. 3. Hæmopoietic diseases, such as Hodgkin's disease and leukæmia. 4. Malignant disease, such as sarcoma or carcinoma.

Tumours of the Mediastinum

Varieties. *Simple tumours* are rare. A lipoma may fill the anterior mediastinum. Other simple tumours include a myoma, neurofibroma, chondroma, osteochondroma, persistent thymus and retrosternal goitre.

Malignant tumours may be carcinoma, sarcoma or ganglio-neuroblastoma. Carcinoma probably is always secondary to a growth in the bronchi or lungs, and some of the mediastinal sarcomata formerly described are probably of the nature of oat-celled carcinoma of the bronchus. Lymphosarcoma, Hodgkin's disease or leukæmia may also affect the mediastinal lymph nodes.

Clinical Findings. The special features of new growth of the mediastinum are the pressure effects, which are known as *the mediastinal syndrome*. Certain structures may be compressed. The trachea or bronchi : There is cough, dyspnœa or stridor and collapse of the lung. The nerves : The vagus, recurrent laryngeal, sympathetic, phrenic or intercostals may be affected. Pressure may result in slowing or acceleration of the pulse, hoarseness, inequality of the pupils, hiccough, paradoxical movement of one side of the diaphragm (up with inspiration and down with expiration), and pain in the chest or arm. The arteries : The pulses may be unequal, or the blood supply to one lung may be interfered with, and gangrene ensue. The veins : The superficial veins of the chest may dilate. The superior vena cava may be obstructed, with reversal of flow in the veins in the chest wall, the current being now from above downwards in the upper part of the chest. Œdema may also be seen in the face, neck, chest or arm, the lungs may be hyperæmic from back pressure, or a pleural effusion may develop. The lungs : A portion of the lungs may collapse. The œsophagus : Pressure will result in dysphagia. The thoracic duct : A chylous pleural effusion may develop. The early symptoms are thus very variable ; a persistent ineffective cough may be complained of, or pain in the chest or arm may be first noted. The symptoms and signs are usually indistinguishable from those of new growth of the lungs. The diagnosis is aided by the X-ray examination, and the determination of the Wassermann reaction, which helps in the exclusion of an aneurysm.

Treatment. This is purely palliative in all malignant cases, as the prognosis is hopeless. A simple tumour, such as a lipoma of the anterior

mediastinum or a retrosternal goitre, can frequently be removed surgically. X-ray treatment should be given in cases of Hodgkin's disease, leukæmia or sarcoma. The immediate response in sarcoma or Hodgkin's disease is often good, but there is inevitably recurrence of the growth.

Cysts of the Mediastinum

A dermoid or a hydatid cyst is occasionally met with (see also p. 196). Treatment is surgical. Mesothelial mediastinal cysts are not very uncommon. They are also known as spring-water cysts from the clear fluid they contain, or pericardial celomic cysts. They probably arise from a fold in the advancing pleural cavity at the 15-mm. embryo stage. The fold is cut off and connective tissue laid down around it. They usually occur in the anterior inferior mediastinum, and radiologically are seen as a rounded shadow in the cardio-phrenic angle, on the right side. They are easily removed surgically. The differential diagnosis includes the following: a fat pad in the cardio-phrenic sulcus, a lipoma, a dermoid, a teratoma, a neurofibroma, a diaphragmatic hernia, a hump of the antero-mesial portion of the diaphragm, a cardiac aneurysm, unilateral sacculated pericarditis, a hamartoma and primary or secondary carcinoma of the lung.

THE DIAPHRAGM

Hiccough

(*Singultus*)

Etiology. Sudden diaphragmatic contractions with reflex closure of the glottis may be due to alimentary, nervous or renal causes. 1. Alimentary causes include: Irritation of the œsophagus or stomach, as by tobacco smoke and pungent articles of food, hiccough may also occur in association with dilatation of the stomach, gastritis, enteritis, peritonitis or intestinal obstruction. 2. Nervous causes may be central, such as a cerebral tumour, meningitis, epilepsy, encephalitis lethargica or hysteria; or peripheral, such as a reflex from a mediastinal tumour, pericardial effusion or diaphragmatic pleurisy. 3. Renal causes, as in chronic nephritis or uræmia. *Tonic spasm* of the diaphragm may be due to strychnine poisoning, tetanus, hydrophobia or laryngismus stridulus.

Treatment. If possible the cause should be removed. The clonic spasm may sometimes be abolished by holding the breath, or by drinking a glass of water. In severe cases it may be necessary to prescribe sedatives such as phenobarbitone, $\frac{1}{2}$ to 1 gr. (30 to 60 mg.) t.d.s., or the hypodermic injection of diamorphin. hydrochlor. $\frac{1}{4}$ gr. (7.5 mg.). Inhalation of the vapour from a capsule of amyl nitrite may prove successful. CO_2 may be inhaled by breathing in and out of a paper bag held tightly over the nose and mouth, or 7% CO_2 and oxygen may be inhaled through a mask for 5 or 10 minutes. The intravenous injection of 50 mg. of chlorpromazine (Largactil) may cause an immediate cessation of hiccough. The phrenic nerve may be injected with procaine, or the effect of spraying the skin of the neck over the phrenic nerve with ethyl chloride may be tried, if the condition is unilateral,

as shown by X-ray examination. Sneezing, induced by inhaling real snuff or by tickling the nose with a feather, may be successful when other methods have failed.

Diaphragmatic Pleurisy

This has been referred to on p. 199.

Diaphragmatic Paralysis

Etiology. This may be due to central causes affecting the phrenic nuclei, such as poliomyelitis, a hæmorrhage or a tumour. The phrenic nerve may be involved by neuritis or by pressure of a tumour, or it may be crushed or divided surgically, or after division avulsed from its diaphragmatic terminations.

Clinical Findings. X-ray examination will show the extent of diaphragmatic movement. One-half may be completely paralysed, in which case the diaphragm on that side is usually raised, or it may show paradoxical movement on the affected side, rising with inspiration and falling with expiration. This is often associated with a mediastinal neoplasm.

Hernia of the Diaphragm

(*Thoracic Stomach*)

Definition. Protrusion of an abdominal viscus, usually the stomach, through the diaphragm into the thoracic cavity.

Etiology. Diaphragmatic hernia may be traumatic or non-traumatic. Sixteen per cent. are traumatic. The non-traumatic ones are either congenital or acquired. The congenital ones are usually due to absence of a part of the diaphragm and are met with in infants. The non-traumatic ones are due usually to developmental diaphragmatic defects and show themselves later in life. They are subdivided into 1. *Œsophageal hiatus hernia*. This may be a true hernia with a sac, or a false hernia due to a congenital short *œsophagus*. 2. *Pleuro-peritoneal hernia*, the weakness of the diaphragm occurring at the site of the foramen of Bochdalek. 3. *Postero-lateral diaphragmatic hernia*. 4. *Anterior herniation* through the site of the foramen of Morgagni (see Fig. 15).

Clinical Findings. The symptoms in infancy are cyanosis, dyspnoea and vomiting. In adults the symptoms may be mistaken for those of peptic ulcer, cholecystitis, *œsophageal* or intestinal obstruction, anemia or coronary occlusion. Strangulation of an intestinal diaphragmatic hernia may constitute a surgical emergency. The anemia is usually hypochromic and microcytic. Earache may be associated with hiatus hernia. Hæmatemesis may occur or the occult blood test on the feces be positive. The diagnosis is established by a barium swallow and meal, with the patient in the Trendelenburg position.

Treatment. Immediate surgical repair is required for diaphragmatic hernia in infants. In adults small symptomless herniæ require no treatment. With moderate symptoms the diet should be bland, with small and frequent meals. Neutralising substances are required for

mediastinum or a retrosternal goitre, can frequently be removed surgically. X-ray treatment should be given in cases of Hodgkin's disease, leukaemia or sarcoma. The immediate response in sarcoma or Hodgkin's disease is often good, but there is inevitably recurrence of the growth.

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Hiccough

(Singultus)

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Treatment. If possible the cause should be removed. The clonic spasm may sometimes be abolished by holding the breath, or by drinking a glass of water. In severe cases it may be necessary to prescribe sedatives such as phenobarbitone, $\frac{1}{2}$ to 1 gr. (30 to 60 mg.) t.d.s., or the hypodermic injection of diamorphin, hydrochlor. $\frac{1}{4}$ gr. (7.5 mg.). Inhalation of the vapour from a capsule of amyl nitrite may prove successful. CO₂ may be inhaled by breathing in and out of a paper bag held tightly over the nose and mouth, or 7% CO₂ and oxygen may be inhaled through a mask for 5 or 10 minutes. The intravenous injection of 50 mg. of chlorpromazine (Largactil) may cause an immediate cessation of hiccough. The phrenic nerve may be injected with procaine, or the effect of spraying the skin of the neck over the phrenic nerve with ethyl chloride may be tried, if the condition is unilateral,

CHAPTER III

THE CARDIO-VASCULAR SYSTEM

Introductory. In this section attention will be directed to the pericardium, heart, arteries and veins. The indications for special investigations will be noted. These include X-ray examinations to determine the size, shape, position and movements of the heart and aorta, electrocardiograms, cardiac catheterisation and angiocardio-graphy.

X-ray Kymography. This provides a record on a film of the movements of the heart and aorta. A grid, made of a lead plate, with narrow horizontal slits equidistant from each other, is placed between the patient and the film. The grid moves slowly downwards during the exposure, which lasts 3 seconds. The heart outline appears on the film with a serrated edge, each serration corresponding with a beat of the heart. Diminution or absence of pulsations of a part of the heart, as may occur with a cardiac aneurysm, results in diminution or absence of serrations over the corresponding portion of the heart outline. Kymography appears of value chiefly in the diagnosis of a cardiac aneurysm or pericardial effusion, or in differentiating a pulsating mediastinal tumour from an aortic aneurysm.

The Electrocardiogram. The P wave is due to atrial systole and constitutes the atrial complex. QRST occur during ventricular systole and constitute the ventricular complex. T to P represents diastole.

Angiocardio-graphy. 45 to 60 ml. of 70% diodone are injected into the basilic vein in adults, and about 20 to 30 ml. into the saphenous vein in children. Eight to ten X-ray exposures of the chest are made over about 8 seconds, beginning at the commencement of the injection. Postero-anterior and occasionally oblique views are taken.

THE PERICARDIUM

Acute Fibrinous Pericarditis

(Dry Pericarditis. Plastic Pericarditis)

Definition. Acute inflammation of the pericardium with little or no fluid formation.

Etiology. Varieties. The chief varieties of pericarditis are rheumatic, pyogenic, tuberculous, traumatic, secondary to myocardial infarction, uræmic, and associated with adjacent malignant lesions. A benign type is also described complicating upper respiratory infections, which occurs chiefly in young men. It is sometimes met with in scarlet fever, meningococcal meningitis, actinomycosis, undulant fever, primary atypical pneumonia, systemic lupus erythematosus, polyarteritis nodosa and myxœdema. The exciting organisms include the *Streptococcus pneumoniae* (pneumococcus), the streptococcus, the staphylococcus, the

heartburn. The patient should sleep with the head of the bed raised on blocks. Phrenic crush is often very successful in quickly checking the bleeding causing anæmia and in relieving the coronary type of pain. For more severe types of hernia surgical repair is necessary.

Eventration of the Diaphragm

Definition. A bulging of the affected side of the diaphragm into the thorax.

Etiology. The eventration is probably due to a congenital weakness of the diaphragm, rather than to an affection of the phrenic nerve ; but in some cases there may be a birth injury of the phrenic nerve. Acquired cases result from lesions of the phrenic nerve, often due to poliomyelitis, or after pneumonectomy.

Pathology. The affected half of the diaphragm is thin, translucent, and consists of fibrous tissue with a few muscle fibres. The phrenic nerve on the affected side may be smaller than its fellow, but does not show evidence of neuritis. In about 94% of cases the left side of the diaphragm is affected.

Clinical Findings. The patient does not usually make any complaint pointing to a lesion of the diaphragm, but the signs found on examination may resemble those of a diaphragmatic hernia. The lesion is diagnosed by X-ray examination, the affected side of the diaphragm may lie at the level of the third costal cartilage, and show paradoxical movement.

Treatment. No special treatment is required.

Paroxysmal Flutter of the Diaphragm

This is a rare condition in which the symptoms resemble those of angina pectoris. Screen examination shows rapid oscillations of one-half of the diaphragm, superimposed on somewhat jerky movements synchronous with thoracic respiration. Rapid relief has been recorded by spraying the skin of the neck over the phrenic nerve with ethyl chloride.

Prognosis. This must vary with the cause, but pericarditis is always a serious condition, and if death does not ensue, time alone will show what permanent damage will remain. In chronic nephritis, pericarditis is usually a signal of impending death.

Treatment. The patient must be kept strictly at rest in bed, lying nearly flat, or slightly propped up, or turned a little to one side or the other. Ung. methyl. salicyl. (B.P.C.) should be applied on lint daily to the præcordium in rheumatic cases. Pain is relieved by the injection of morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.), or of pethidine hydrochlor. 100 mg., or by pulv. ipecac. et opii 10 gr. (0.6 G.) taken by mouth, for an adult, at night. The treatment is that of the underlying cause. In rheumatic cases a mixture containing Sod. salicyl. 10 gr. (0.6 G.), sod. bicarb. 20 gr. (1.2 G.), syr. aurant. 80 m. (2 ml.), aquam ad 1 fl. oz. (30 ml.) is given, 1 fl. oz. (30 ml.) t.d.s. p.c. A careful watch should be kept as signs of collapse may occur. Should this happen, the salicylate mixture is discontinued, and cardiac stimulants should be given such as nikethamide (Coramine) 2 ml. subcutaneously every 4 hours. The diet should be fluid or semi-solid during the acute stage. The patient must be kept in bed for at least 3 months after the temperature and pulse have returned to normal, without salicylates being taken. Subsequently very limited walking exercise is allowed for 9 months, and no games should be played for 2 years.

Pericardial Effusion

The following varieties may occur: 1. Clear: Sero-fibrinous pericarditis. Hydropericardium. 2. Purulent: Pyopericardium. 3. Hæmorrhagic: Hæmopericardium. Hæmoseropericardium. Hæmohydropericardium.

Pericarditis with Effusion

(Sero-fibrinous Pericarditis. Seropericardium)

Definition. An inflammatory serous pericardial exudate.

Etiology. Pericarditis with effusion is usually preceded by acute fibrinous pericarditis, but in some cases, especially in children, it develops insidiously.

Pathology. The fluid varies in amount from 1 to 2 fl. oz. (30 to 60 ml.) to 2 or 3 pints (1.2 or 1.8 litre). It is yellowish-green in colour, clear or slightly turbid, specific gravity about 1.018, and it clots on standing. The pericardium is thickened by a fibrinous exudate and there is usually myocardial degeneration. The Coxsackie virus has been found in the fluid in one or two cases.

Clinical Findings. The patient is a child or an adult. Usually there is a history of acute dry pericarditis, in the course of which the effusion occurred. Rarely the pericardial effusion is discovered without such a history, the patient being a child, who is off colour, looks pale and complains of shortness of breath. The patient with such an effusion complains chiefly of dyspnoea, a feeling of distress or actual pain in the præcordium, and palpitations. Increasing mediastinal pressure may result in dysphagia, vomiting, hiccough, cough or hoarseness due to

Neisseria gonorrhoeae (gonococcus), the *E. coli*, the *Salmonella typhi* (*B. typhosus*), and the *Mycobacterium tuberculosis*.

Pathology. A fibrinous exudate forms, which is localised or diffuse. There may be a shaggy layer, giving a "bread and butter" effect. A small serous exudate is not uncommon. Evidence of an old healed lesion is sometimes found at autopsy in the form of a thickened white area or "milk spot."

Clinical Findings. If the patient is a child, he is frequently suffering from rheumatism or chorea; dry pericarditis in an adult may be due to any of the causes mentioned above, wherein in old age it is often a terminal event. It may be associated with rheumatoid arthritis, with gout, or with the administration of phenylbutazone. Pain is complained of if the inflammation affects the lower third of the pericardium which is supplied by the phrenic nerve, or if the pleura is also involved. It is localised to the præcordium, but at times radiates to the neck, arm or abdomen. It is generally intensified by breathing, coughing or moving. In some cases only slight discomfort or a dull ache is noticed.

On Examination: The patient usually looks ill and anxious, and he may be pale. The temperature is raised to about 101° F. (38.3° C.), and the pulse rate to 100 or 120. The chest. Inspection: A rapidly beating cardiac impulse is often seen. Palpation: A "to and fro" pericardial friction rub may be felt. Percussion: The cardiac dulness is sometimes, but not always, enlarged, but such enlargement is not due to the pericarditis. Auscultation: The diagnostic friction rub is heard. This is a "to and fro" rub, not quite synchronous with systole and diastole, and usually intensified by pressure of the stethoscope. It may be very faint, or loud and creaking (*bruit de cuir neuf*) and audible without a stethoscope. It may be diffuse, or localised to the base or apex of the heart. In some cases it is heard better on deep inspiration, or when the patient is sitting. Further, it is sometimes inconstant, being heard at one examination, and not at the next. The electrocardiogram usually shows an early elevation of the S-T segment which resumes the isopotential level in a few days, and is followed by inversion of the T wave, especially in lead II.

Differential Diagnosis. The pain must be distinguished from that due to pleurisy or to angina pectoris. Dry pericarditis is often a complication of myocardial infarction. The rub has to be differentiated from pleuro-pericardial or pleural friction, and from a double aortic murmur. With pleuro-pericardial friction the rub is generally heard at the left or right border of the heart, disappearing with full inspiration, and returning with expiration. With pleural friction the rub may disappear completely when the breath is held. With a double aortic murmur the characteristic features are the site and area of conduction of the murmur, the absence of pain, the blood pressure readings and the cardiac enlargement.

Course and Complications. In the majority of cases the pericarditis resolves, without the formation of an effusion which can be detected clinically. In some instances a serous, hæmorrhagic, or purulent pericardial exudate develops. Adherent pericardium is a likely sequela.

tip does not extend to the edge of the shadow cast by the heart and pericardial effusion. With a left-sided pleural effusion the heart is displaced towards the right, the heart sounds are clear, and, unless the fluid is loculated, the signs of fluid are found at the left base behind. X-ray examination will also serve to differentiate.

Course and Complications. With recovery the fluid absorbs and adhesions remain between the layers of the pericardium. The rate of absorption varies, from a few days to several weeks. Reappearance of the friction rub is an indication that this has taken place, and pain may or may not recur. In some instances the fluid becomes purulent.

Prognosis. A pericardial effusion is always a serious event, the immediate prognosis varying with the underlying cause. Thus with the infectious fevers recovery usually occurs, but in severe septic infections a pericardial effusion is generally the herald of death.

Treatment. The general treatment is as for acute fibrinous pericarditis. Special treatment involves paracentesis of the pericardium. This should not be lightly undertaken, as the results are very discouraging. It may be necessary if the effusion increases and seriously embarrasses the heart's action, as shown by increasing rapidity and weakness of the pulse, greater dyspnoea and restlessness, or if pus is suspected. Procaine, 1 ml. of a 2% solution, should be injected in the fourth left space close to the edge of the sternum, or 1 inch (2.5 cm.) external to it, in order to avoid the internal mammary artery, until the pericardium is pierced, when the fluid can be withdrawn into the syringe. A fine trocar and cannula are then inserted, and the fluid allowed to drain away. If, however, pericardial friction is audible at this site, the puncture should be made in the angle between the xiphoid process and the left costal cartilages, the needle then being passed upwards and backwards at an angle of 30° to the skin, until the pericardium is pierced. Alternatively the needle may be inserted in the fifth or sixth left space just medial to the left border of the pericardial dulness. A loculated posterior pericardial effusion may be aspirated from the back. The left arm is brought forward and the needle is inserted in the seventh or eighth left space in the mid-scapular line, to a depth of 2 or 3 inches (5 or 7.5 cm.).

Hydropericardium

Definition. A transudate of fluid into the pericardium.

Etiology. Hydropericardium is most frequently associated with heart failure or chronic nephritis. Rarely it is due to mediastinal venous obstruction from enlarged lymph nodes, new growths or aneurysm, or to the severe cachexia of leukaemia or of beri-beri.

Pathology. The fluid is clear, pale, of low specific gravity (about 1.012), and contains less than 3% of protein.

Clinical Findings. The symptoms are usually masked by those of the primary condition. A considerable amount of fluid may accumulate without definite symptoms, as there is no preliminary stage of pericardial friction and the rate of output of the transudate is slow. The physical

recurrent laryngeal paralysis. Insomnia is often a very troublesome feature.

On Examination : The patient is pale and the lips and ears may be somewhat cyanosed. He is often restless and cannot lie flat on his back, wishing to be propped up or turned on the left side. The cervical veins may be distended. The chest. Inspection : There may be bulging of the præcordium, with diminished expansion on the left side of the chest. Often no cardiac impulse is visible, but a diffuse wave may be seen over the third, fourth and fifth left intercostal spaces. Diaphragmatic movement may be abolished or weakened on the left side. Palpation : The cardiac impulse is feeble or absent. Pericardial friction, if previously present, disappears. Œdema of the chest wall over the præcordium may be demonstrated by pitting on pressure. Percussion : The area and intensity of the cardiac dullness are increased. It is described as pear-shaped, with the stalk upwards. The upper level of dullness may alter with the patient in the erect and recumbent positions. The dullness obliterates the normal area of pulmonary resonance in the cardio-phrenic angle, at the fifth right space, near the sternum (Rotch's sign). On the left side the dullness may extend out to the axilla. Auscultation : The heart sounds become progressively weaker as the effusion increases. A friction rub, if previously present, disappears, although it may remain at the base, or be audible in the erect, but not in the recumbent position. The apex of the heart, as judged by the intensity of the heart sounds, lies internal to, and usually above the apex of the cardiac dullness. The lungs : The pressure of the pericardial effusion, especially if localised to the posterior part of the pericardial sac, may give rise to special signs. Thus a small area of dullness may be found near the inferior angle of the left scapula, with bronchial breathing, bronchophony and whispering pectoriloquy (Bamberger's or Ewart's sign). The pulse is usually rapid, and it may increase in force with expiration and weaken with inspiration (*pulsus paradoxus*). Cardiac tamponade is the term applied to circulatory failure due to rise of intrapericardial pressure. The venous pressure rises, the blood pressure falls, the pulse rate rises and there is peripheral vasoconstriction. The blood usually shows a leucocytosis. An X-ray examination will generally reveal a characteristic shadow of the effusion. This is globular in the recumbent position and pyriform when the patient is erect. With a dilated heart the shadow remains practically unaltered in shape with change of posture. The absence of normal pulsations is shown by X-ray kymography.

Differential Diagnosis. A pericardial effusion may be mistaken for a dilated heart or for a left-sided pleural effusion. In dilatation of the heart the apex beat is usually palpable, although weak. The dullness over the heart is not so stony in character, and Rotch's sign is not present. The shape of the dullness is also different, the upper border being more flat and at a lower level. The heart sounds are more distinctly heard, pressure signs are not found behind at the left base, and the X-ray shadow differs, as described above. If a cardiac catheter is inserted into the right atrium, X-ray examination will show that its

Etiology. Hæmoseropericardium is usually due to malignant disease or tuberculosis of the pericardium.

Clinical Findings. These closely resemble the findings in sero-fibrinous pericarditis.

Hæmohydropericardium

Definition. A pericardial transudate, containing blood.

Etiology. Hæmohydropericardium is usually associated with heart failure.

Calcified Pericardium

This may be a sequela of acute inflammatory pericarditis, especially pyopericardium, or of a chronic pericardial effusion. It is usually discovered by X-ray examination. It may cause no symptoms, or result in cardiac distress.

Pyopneumopericardium

Definition. Gas and pus in the pericardium.

Etiology. The gas may come from various sources, such as :
1. The exterior : In trauma from wounds or by operation on the pericardium. 2. The lungs : In tuberculosis, carcinoma, gangrene or pyopneumothorax. 3. The abdomen : In subphrenic abscess. 4. The œsophagus : With an ulcerating growth. 5. Gas-producing organisms, in a pericardial effusion. This is generally a post-mortem event.

Pathology. A purulent exudate is present.

Clinical Findings. The patient may complain of sudden præcordial pain, but at times the onset is insidious.

On Examination : Typical signs depend upon the presence of gas and fluid in the pericardium. There is an area of hyperresonance over the præcordium, which may move with alteration in the position of the patient. On auscultation a loud churning sound is heard.

Differential Diagnosis. If gas alone is present, it may be located behind the heart and cause no definite signs. When in front of the heart the hyperresonance may suggest acute interstitial emphysema which has spread to the anterior mediastinum. An X-ray examination will establish the diagnosis, the outline of the pericardium standing out as a definite line, with a translucent space between it and the heart shadow.

Treatment. This is similar to that described for purulent pericarditis. The air may be allowed to escape through a needle if there is severe cardiac distress.

Pneumopericardium

This may complicate a pneumothorax, and is probably due to a congenital pleuro-pericardial communication.

Adherent Pericardium

Definition. Adhesions between the layers of the pericardium, or between the pericardium and surrounding structures.

signs correspond with those described for sero-fibrinous pericarditis. There is usually oedema in other parts of the body.

Treatment. It is rarely necessary to tap the pericardium, and the treatment is that appropriate to the causative condition.

Purulent Pericarditis (*Pyopericardium*)

Definition. Pus in the pericardium.

Etiology. Purulent pericarditis is usually a complication of pyæmia, especially when there is osteomyelitis, or it is associated with tuberculosis or new growths of the pericardium. An empyema or pulmonary abscess may lead to direct spread of infection to the pericardium. Tuberculous pericarditis is usually secondary to mediastinal lymph node tuberculosis.

Clinical Findings. In addition to the symptoms and signs of sero-fibrinous pericarditis, the temperature shows marked diurnal variations, the pulse is more rapid, and sweats or rigors may occur. There is generally a leucocytosis of over 12,000 per c.mm. In rare cases the patient is afebrile.

Differential Diagnosis. The nature of the fluid can only be determined by exploratory puncture.

Course and Complications. The disease is usually rapidly fatal, but the course may be very prolonged in tuberculous infections, and there may be calcification of the pericardium. The fluid may rupture through to the left pleura, with empyema formation.

Prognosis. This is very grave. Some cases of tuberculous pyopericardium undergo a spontaneous cure.

Treatment. The pericardial sac should be aspirated, the needle being inserted between the xiphoid process and the left costal cartilages, in order to avoid infecting the pleura. A course of penicillin should now be given, 600,000 units of a procaine preparation every 12 hours, intramuscularly, for 3 to 4 weeks. In tuberculous cases antimycobacterial drugs should be given as for pulmonary tuberculosis. If the patient's general condition permits, and the fluid is not tuberculous, the pericardium should be drained surgically.

Hæmopericardium

Definition. Blood in the pericardium.

Etiology. The blood enters the pericardium from rupture of the heart, coronary artery or intrapericardial portion of the aorta. The cardiac leak may result from an infarct, an aneurysm of the heart, or it may be due to external trauma or to a perforating oesophageal wound. Hæmopericardium is a rare occurrence in purpura or scurvy.

Clinical Findings. The patient suddenly dies.

Hæmoseropericardium

Definition. An inflammatory serous pericardial exudate, containing blood.

New Growths and Cysts of the Pericardium

The pericardium may be invaded by a mesothelioma of the pleura, by spread of carcinoma or by a primary sarcoma. A hydatid cyst sometimes develops in the pericardium and a dermoid cyst of the mediastinum may rupture into it.

THE NEURO-MYOCARDIUM

Disorders of Rate and Rhythm

Introductory. Normally the impulses for the heart beat arise in the sino-atrial node in the right atrium, whence waves of excitation spread over both atria to the atrio-ventricular node, situated at the posterior and right edge of the atrial septum. The impulse then spreads to the ventricles along the bundle of His. The S-A node is under a double nervous control, the sympathetic accelerating and the vagus retarding the output of stimuli. Normal cardiac activity is therefore a sinus rhythm. Cardiac irregularities may be due to : 1. Sinus disorders : Simple tachycardia. Simple bradycardia and sinus arrhythmia. 2. Increased muscular irritability : Paroxysmal tachycardia. Premature systoles. Atrial fibrillation. Atrial flutter. Ventricular fibrillation. 3. Diminished conductivity : Heart-block. 4. Defective contractibility : Pulsus alternans. 5. Disturbed diastolic filling : Pulsus paradoxus. These varieties will now be briefly considered.

Simple Tachycardia

Etiology. Simple tachycardia may result from diverse causes, such as exercise, emotion, fevers, hyperthyroidism, chronic infections, anæmia, hæmorrhage, alcohol, cordite, atropine, tea, coffee, tobacco and thyroid extract. It may be due to a rise of pressure in the right atrium causing a release of vagal tone, or to stimulation of the pacemaker in the heart.

Clinical Findings. The pulse rate at rest is usually between 90 and 120, and after exercise it may rise to 150 or 180, taking longer than 2 minutes to return to its resting rate. In such a case the exercise tolerance is considered fair, moderate or poor, according to the pulse figures and the distress engendered by the test. In other instances there are attacks of palpitations, during which the patient is conscious of the heart's action. Throbbing may be felt in the neck, and there may be giddiness or buzzing in the ears. A sense of præcordial distress or pain may also be noticed.

On Examination : There is usually no cardiac enlargement. A soft systolic murmur, heard at the apex or base, may accompany the first sound.

Treatment. Digitalis is not usually of value unless an organic cardiac lesion is present. Phenobarbitone $\frac{1}{2}$ gr. (30 mg.) t.d.s. is often helpful. A search should always be made for an underlying cause, such as a septic focus, pulmonary tuberculosis or hyperthyroidism.

Etiology. Non-constrictive adherent pericardium is usually a sequel of acute pericarditis. The majority of cases are therefore rheumatic, the minority being caused by tuberculosis, sepsis, cardiac infarction, trauma, malignant disease and polyserositis (Concato's disease).

Pathology. There are four varieties: 1. Adhesions are present between the visceral and parietal pericardial layers. 2. The adhesions also extend loosely outwards to the diaphragm, chest wall and pleura (*pericarditis interna et externa*). 3. The pericardium becomes solid and thick or even calcified. 4. There is also thickening of the mediastinal connective tissue (chronic indurative mediastino-pericarditis). The last two varieties are called constrictive pericarditis. They impede the cardiac output and obstruct the venous inflow. The heart is not grossly enlarged unless valvular disease or hypertension is present.

Clinical Findings. Unless there is constrictive pericarditis the adhesions usually give rise to no symptoms. Broadbent's sign indicates extra-pericardial adhesions to the chest wall and diaphragm. Systolic retraction is seen in the tenth or eleventh space behind, on the left side in the scapular angle line. No special treatment is required unless constrictive pericarditis is present.

Chronic Constrictive Pericarditis

(Pick's Disease)

Etiology. Rheumatism is not a cause. The majority of cases are due to tuberculosis, a few are due to sepsis and in others the cause is not known.

Pathology. Pick in Germany described pericarditic pseudocirrhosis of the liver in 1896. A similar condition was described by Chevers at Guy's Hospital in 1842. There is pericarditis, enlargement of the liver, perihepatitis and ascites.

Clinical Findings. The patient complains of shortness of breath, swelling of the abdomen and of the legs.

On Examination: The upper half of the body is often thin, but the abdomen is very swollen. The cervical venous pressure is raised, the liver is enlarged, there is ascites and œdema of the legs. The pulse is small and may weaken during inspiration and become stronger with expiration (*pulsus paradoxus*). There is peripheral vaso-constriction with pallor, cyanosis and coldness of the extremities. The blood pressure is usually low. The heart is often not enlarged or only moderately so, and X-ray examination of the heart shows diminished pulsation. Calcification of the pericardium is seen in some cases. The electrocardiogram shows low voltage curves with flat or slightly inverted T waves.

Treatment. Pericardial resection is indicated to relieve the compression of the heart and great veins. Before operation a pleural effusion should be aspirated, ascites tapped and mersalyl given. The operation, however, should not be deferred until there is no ascitic fluid. In carefully selected cases a cure may be expected in about 50%, but the operative mortality is about 10%.

vagus by a mediastinal tumour may also cause bradycardia. Physiological bradycardia is met with in tall athletes, in adolescence, and old age.

Clinical Findings. The apex rate varies between 40 and 60. The electrocardiogram shows no evidence of heart-block.

Treatment. No special treatment is required beyond that indicated for the underlying condition.

Sinus Arrhythmia

(Physiological or Juvenile Cardiac Irregularity)

Etiology. Sinus arrhythmia is met with in young people and during convalescence from febrile illnesses. It is due to alteration of vagal tone with respiration and indicates that the impulse for the heart beat arises in the sino-atrial node.

Clinical Findings. The patient is usually a young adult. Sinus arrhythmia generally causes no symptoms, but when discovered it may be mistaken for some serious cardiac irregularity. The pulse rate is found to slow during expiration and quicken during inspiration. This may occur periodically and only be detected when the patient is asked to breathe slowly and deeply. The irregularity disappears when the heart beats rapidly, as after exercise. The electrocardiogram shows that the alteration is due to variations in the length of diastole.

Treatment. Sinus arrhythmia in itself is of no pathological import, and requires no treatment, but it may be associated with all varieties of heart disease.

Paroxysmal Tachycardia

The following varieties are described: 1. Simple paroxysmal tachycardia. 2. Nodal tachycardia. 3. Ventricular tachycardia. 4. Paroxysms of atrial flutter. 5. Paroxysms of atrial fibrillation.

Simple Paroxysmal Tachycardia

Etiology. The paroxysms of tachycardia are probably due to impulses arising at a new focus in the atrium, constituting a regular series of premature systoles. Some cases are associated with pregnancy, others remit during pregnancy. Exertion, emotion or flatulence may induce an attack.

Clinical Findings. The patient complains of periodical attacks of palpitations, which may be accompanied by faintness, dyspnoea and præcordial distress.

On Examination: The patient may be pale, somewhat cyanosed and sweating. The apex and pulse rate vary usually between 140 and 250. The rhythm is regular and the rate is not slowed on lying down. The systolic blood pressure falls and the output from the heart is diminished. In severe cases signs of cardiac decompensation are evident, such as dilatation of the heart, œdema of the lungs and legs, and engorgement of the liver. The electrocardiogram shows a rapid regular rhythm.

The Effort Syndrome

(*Da Costa's Syndrome. Cardiac Neurosis. Disorderly Action of the Heart. D.A.H. Soldier's Heart. Neuro-circulatory Asthenia*)

Etiology. This syndrome is a frequent occurrence in wartime amongst untrainable or imperfectly trained soldiers. In civilian life it is said to be more common in women and it also occurs in children. Various views are held as to its nature. 1. That it is a neurosis. 2. That it is due to chronic sepsis. 3. That it results from over-smoking. 4. That it is the product of effort and poor physique. It is unlikely that effort alone will cause it, and the symptoms do not resemble those produced by strenuous exercise in a healthy person. In the majority of cases there is a mental background of fear, anxiety or a compensation neurosis, and the physical condition is often poor.

Clinical Findings. The patient is usually a young adult who complains of breathlessness, sighing, palpitations, fatigue, sweating, nervousness, dizziness, and left inframammary pain.

On Examination. No signs of organic disease are found. The physique is often poor, there is vasomotor spasm of the extremities as evidenced by cold or bluish-red hands and feet, and abnormal sweating is seen in the axillæ and on the hands and feet. The heart: The apex beat may be forcible but there is usually no cardiac enlargement. The heart sounds are normal, but the first sound may be accentuated if there is tachycardia. A short soft systolic murmur may be heard at the apex or base. The average resting pulse rate is between 80 and 100. The blood pressure is usually normal. The exercise tolerance may be impaired, but is often normal.

Differential Diagnosis. Such conditions as rheumatic carditis, early mitral stenosis, thyrotoxicosis, pulmonary tuberculosis, pleurisy, angina pectoris, hypoglycæmia and malingering must be excluded. A carefully taken history will indicate the correct diagnosis in the majority of cases, and this is confirmed by the characteristic symptoms and signs.

Prognosis. This is unfavourable, only about 25% of soldiers suffering from the syndrome can be rendered fit for full military duties. Medical boards should not enlist neurotics, who will never make efficient soldiers.

Treatment. When soldiers are so enlisted, however, an attempt should be made to improve their condition. Properly graduated exercises should be first given to increase the cardio-respiratory efficiency. The patient should be informed of the nature of his complaint and treated as a psychoneurotic.

Simple Bradycardia

Etiology. Simple bradycardia may be due to vagotonia, occurring during convalescence from severe illnesses such as influenza or typhoid fever. It is also met with in association with starvation, nervous exhaustion, cerebral abscess, tumour or hæmorrhage, meningitis, myxœdema, jaundice, uræmia, vaso-vagal attacks, overdosage of digitalis, and at times with myocardial degeneration. Irritation of the

over 50% of cases. In some cases it may lead to leucopenia. Digitalis should not be given.

Paroxysms of Atrial Flutter

This is a common cause of paroxysmal tachycardia. The apex and pulse rate are about 160, the rate is uninfluenced by posture and the rhythm is usually regular. The atrial rate is about 200 to 300. Diagnosis is established by means of the electrocardiogram. The treatment is as for atrial flutter.

Paroxysms of Atrial Fibrillation

The apex and pulse show the typical irregularity of atrial fibrillation and the electrocardiogram confirms the diagnosis. The treatment is as for atrial fibrillation.

Premature Systoles

(Ectopic Beats)

Definition. Interpolation on the normal sinus rhythm of premature contractions arising at some other focus in the heart than the sino-atrial node.

Etiology. Premature systoles are believed to be due to undue excitability of the atrium, A-V node or ventricle. They are commonly met with in middle age, associated with myocardial degeneration. In young people they may occur without any evidence of cardio-vascular lesions. They may be associated with oversmoking, neurasthenia, pregnancy, the administration of digitalis or aconite, or coal-gas poisoning. There are three main varieties, atrial, nodal and ventricular. In about 70% of cases they are ventricular in origin.

Clinical Findings. The patient may be quite unaware of any cardiac irregularity, or he may be conscious of a pause in the cardiac rhythm, as if the heart had missed a beat. This is particularly noticeable when the patient is in bed. He may also complain of palpitations.

On Examination: The pulse may either show a pause due to the premature beat being of insufficient force to reach the wrist (intermittent pulse), or a weak beat may be felt. On listening over the apex a premature and weak contraction will be heard at the moment that the beat is missing or weak at the wrist. An occasional premature contraction may occur, or they may be frequent, causing a gross irregularity. *Pulsus bigeminus*, which may be met with in overdosage with digitalis, consists of coupled beats due to premature systoles. The electrocardiogram will show typical curves and indicate the site of the irregularity.

Differential Diagnosis. Premature systoles must be diagnosed from heart-block or a slow atrial fibrillation. In heart-block, when the pause is felt at the wrist, there is silence on auscultation over the apex. Premature systoles are usually diminished in frequency or abolished by exercise, but with a slow fibrillation it may be impossible to establish the diagnosis without an electrocardiogram.

with normal ventricular complexes. The P wave is often inverted in leads II and III and modified in lead I.

Differential Diagnosis. The sudden onset and cessation, and the constancy of the rate with exercise, rest and change of posture differentiate it from simple tachycardia. The engorgement of the liver may suggest an abdominal lesion, or the signs at the bases of the lungs may simulate pneumonia. The history, signs, and electrocardiogram establish the diagnosis.

Course and Complications. The attack lasts from a few minutes to two weeks and then stops abruptly. Blindness and epileptiform convulsions may occur temporarily. Death during an attack has been recorded in a few cases.

Treatment. The following devices may be employed to abort the attack: Holding the breath, stooping down and breathing deeply, pressure over one carotid sinus but not over both at the same time, pressure on the eyeballs, a tight abdominal binder, ice applied to the præcordium, swallowing a hard article of food such as a crust of bread, or the induction of vomiting by faucial irritation. Cholinergic drugs such as methacholin. chlorid. (Mecholyl chloride) 10 to 25 mg., may be injected subcutaneously, or a carbachol tab. 2 mg., taken by mouth. If vomiting, defæcation or faintness is produced by the drug, atropin. sulph. 1/100 gr. (0.6 mg.) should be injected intravenously. If the paroxysm persists digoxin, 1 mg., may be given intravenously. Quinidine, 3 gr. (0.2 G.) by mouth is also recommended, but the patient may be sensitive to the drug.

Nodal Tachycardia

Paroxysms of premature systoles arise in the A-V node, resulting often in a simultaneous contraction of the atria and ventricles. In the electrocardiogram the P-R interval may be shortened and the P wave inverted, or the P and R waves are fused, or the P wave may follow the R wave. The clinical picture and treatment resemble those of simple paroxysmal tachycardia.

Ventricular Tachycardia

This is a rare condition due to a regular sequence of premature ventricular systoles. The ventricles may contract 180 times a minute, while the atrial rate remains at about 80. It is usually associated with severe myocardial damage, coronary occlusion or gross digitalis poisoning. The clinical features closely resemble those of the other varieties of simple paroxysmal tachycardia, but the ventricular beats are often slightly irregular. Treatment consists in giving procaine amide (Pronestyl) by mouth, if the patient can swallow, the dose being 4 tablets (0.25 G. each), followed by 2 tablets every 4 to 6 hours until the paroxysm stops. For very urgent cases an intravenous injection can be given slowly, not more than 1 ml. (100 mg.) per minute, up to a total of 10 ml. The blood pressure should be taken in the other arm during the injection, and, if it falls unduly, the injection should be stopped. Procaine amide is probably successful in restoring a normal rhythm in

treatment. Complications include congestive heart failure, and systemic embolus formation. The latter is especially liable to follow restoration to normal rhythm by the administration of quinidine, a portion of clot being detached from the left atrium. The main arterial supply to a limb may be obstructed, with severe pain. The limb becomes cold and blue, and gangrene may supervene.

Prognosis. This is always grave, although a patient may live for over 10 years with atrial fibrillation.

Treatment. Digitalis is usually prescribed as tablets of the powdered leaf or as digoxin. One grain (60 mg.) of the powdered leaf is equivalent to 0.25 mg. digoxin. For a patient not seriously ill tab. digital. præp. 3 gr. (180 mg.) may be given t.i.d. on the first day, 2 gr. (120 mg.) t.i.d. on the second day, and 1 to $\frac{1}{2}$ gr. (60 to 80 mg.) t.i.d. subsequently. In cases of urgency digoxin should be given orally or intravenously. Three 0.25 mg. tab. digoxin are given t.i.d. on the first day, 2 tabs. t.i.d. on the second day, 1 tab. t.i.d. on the third day and 1 tab. b.i.d. subsequently. In very urgent cases an intravenous injection of 1 mg. of digoxin can be given; 0.5 mg. is put up in 1 ml. of 80% alcohol. This is diluted with nine times its volume of sterile saline and injected slowly. Two hours later 0.25 mg. digoxin can be given by mouth. Symptoms of overdosage of digitalis are undue slowing of the apex beat (below 60), coupling of beats due to a regular sequence of premature systoles, the onset of pulsus alternans, diminution of output of urine and vomiting. Vomiting at the onset of the treatment is usually due to congestion of the gastric mucosa, and not to the digitalis. The urinary output should always be measured while the patient is taking large doses of digitalis. In desperate cases strophanthin-K, 1/200 gr. (0.3 mg.) or ouabaine 1/240 gr. (0.25 mg.) should be injected intravenously.

Electrical conversion by high voltage direct current shock of short duration applied to the chest under anaesthesia has restored regular sinus rhythm in some cases.

The Use of Quinidine. Quinidine should not be used in cardiac failure, mitral stenosis, myocardial infarction, recent embolus or active thyrotoxicosis.

In patients sensitive to quinidine the administration of only 3 gr. (0.2 G.) tablet may result in alarming collapse, with convulsions, coma and death, usually due to ventricular fibrillation. Treatment for quinidine syncope includes external cardiac compression, mouth to mouth respiration, and electric ventricular defibrillation by direct current shock. It is a dangerous drug, and best avoided.

Atrial Flutter

Definition. A condition characterised by rapid and regular atrial contractions of a peculiar nature, and almost invariably accompanied by heart-block.

Etiology. Atrial flutter is usually associated with myocardial degeneration and arteriosclerosis, much less frequently with infective diseases or with thyrotoxicosis.

Prognosis. Premature systoles can usually be disregarded in young people. Later in life, especially if there is evidence of cardio-vascular degeneration, they are generally indicative of myocardial degeneration.

Treatment. Young people should be assured that there is no cause for worry. The patient should not smoke. If there is real distress, particularly at night, ammon. brom. in doses of 5 to 10 gr. (0.3 to 0.6 G.) should be given t.i.d.

Atrial Fibrillation

Definition. A condition characterised by flickering atrial contractions of a peculiar type, with an irregular ventricular response.

Etiology. Atrial fibrillation may be associated with infections, especially with rheumatism and less frequently with scarlet fever, diphtheria, influenza and pneumonia. Mitral stenosis is often associated with fibrillation and it may occur in association with an atrial septal defect. Later in life it may be met with in ischæmic heart disease and in tumours of the heart or lungs. It may occur also in Graves' disease and in hypertensive heart disease and it has been described associated with peppermint addiction.

Pathology. Prinzmetal says there are two types of atrial contraction seen in experimental atrial fibrillation, (a) minute irregular and localised contractions, and (b) large rhythmic contractions passing across the atrium at a rate of 400 to 600 a minute.

Clinical Findings. The disturbance produced varies with the frequency of ventricular contractions. If there is a slow fibrillation there may be no subjective symptoms, but when the ventricle contracts rapidly, cardiac decompensation usually ensues. The patient may complain of palpitations, or of præcordial discomfort, dyspnoea and swelling of the extremities.

On Examination: The patient may or may not be dyspnoeic at rest or on slight exertion, according to the degree of heart failure present. The presystolic murmur of mitral stenosis disappears with the onset of fibrillation if the heart is beating slowly. The rhythm is characteristically completely irregular, the beats also varying in intensity, so that many of the ventricular contractions fail to cause a pulse at the wrist. The pulse: This is completely irregular, and its rate is usually slower than that of the ventricle. Records of pulse rates are therefore quite valueless in determining the rate of the heart. The lungs, liver, abdomen and extremities may show signs of venous stasis and œdema. The electrocardiogram is typical, the P waves are absent and replaced by F waves, and the ventricular complexes are irregular in rate and degree.

Differential Diagnosis. Atrial fibrillation can usually be readily diagnosed by examination of the heart and pulse. Without a tracing, slow fibrillation is difficult to differentiate from premature systoles.

Course and Complications. Atrial fibrillation may occur in paroxysms, the normal rhythm being restored spontaneously from time to time. In other cases, and despite treatment, it persists for indefinite periods, or the normal rhythm may be quickly restored by adequate

lesions caused by rheumatism, diphtheria, influenza, pneumonia, and typhoid or scarlet fever, or to degenerations, especially that caused by syphilis. It may also result from overdosage with digitalis, strophanthin, squills, or quinidine. A gumma, tumour, cyst, or an area of fibrosis or atrophy may be the causative factor in some cases.

Sino-Atrial Block

The impulses arising in the S-A node at times fail to provoke an atrial contraction. The whole heart then misses a beat, but the succeeding contraction occurs at approximately the normal interval. The ventricle may occasionally interpolate a beat on its own ("ventricular escape"), when the heart is beating at the slow rate. It is a cause of dropped beats, and can only be distinguished from atrio-ventricular block by a tracing, the complete absence of the P R T deflections in the electrocardiogram corresponding with the pauses in the heart beats. It is probably of no clinical importance, but if occurring regularly every other beat the pulse is slow, about 30. Exercise usually causes the rate to double and the restoration of normal rhythm can also be effected, except in cases of long standing, by the administration of atropin. sulph., 1/200 gr. (0.3 mg.) in 1 fl. oz. (80 ml.) of water t.i.d.

Atrio-ventricular Block

Delay occurs in the passage of the impulse from the atrium to the ventricle. Four grades may be recognised :—

Grade I. This is the earliest stage, and can only be detected by a tracing. The electrocardiogram shows a prolongation of the P-R interval to more than the normal of $\frac{1}{2}$ second. *Grade II.* The ventricle occasionally fails to respond to the atrial impulse. *Grade III.* The ventricle fails in a regular manner to respond to the atrial stimuli. Thus every fourth ventricular beat may be missing (4 : 3 block) or other sequences such as 3 : 2 or 2 : 1 block may be present. *Grade IV.* There is complete dissociation between atrium and ventricle, the ventricle contracting regularly at its own independent rate of about 30 to 40 a minute. The electrocardiogram allows all these grades of block to be diagnosed with certainty.

Clinical Findings. The patient does not usually notice anything abnormal except in the severe degrees of heart-block. Attacks of unconsciousness (Stokes-Adams syndrome) are liable to occur if the A-V bundle fails to conduct the impulse and the ventricle does not take up its independent rhythm. The attacks come on suddenly with convulsive movements of the face and arms, usually the tongue is not bitten, and there is no involuntary micturition. The patient is pale and falls down, he then becomes cyanosed and the breathing is stertorous. Unless the ventricle begins to beat again, he will die.

On Examination : Auscultation at the apex of the heart will show that the heart misses a beat, when a beat is dropped at the radial pulse. A ventricular rate below 40 a minute is almost always due to complete heart-block. It is often possible to see pulsation in the jugular veins

Pathology. Prinzmetal has shown that flutter depends upon an irritable atrial focus. The atrial rate is about 260 to 330 contractions a minute, and the ventricle usually contracts at half the atrial rate.

Clinical Findings. The patient is usually a male past middle age. He gives a history of attacks of palpitations, usually sudden in onset and in cessation, but the last attack may have persisted.

On Examination: The heart is usually enlarged and the arteries are thickened. A valvular lesion may or may not be present. The pulse and apex rates are generally between 130 and 170, the rhythm is usually regular, and the rate is unaffected by posture and by exercise. Pressure on the carotid sinus will often slow the ventricular rate. In the electrocardiogram regularly recurring dome-shaped "f" waves are seen, with ventricular complexes occurring at regular or irregular intervals, but less frequently than the "f" waves, owing to heart-block.

Differential Diagnosis. Paroxysms of flutter can be differentiated from simple paroxysmal tachycardia by suitable tracings. Atrial fibrillation may be simulated if in flutter the ventricular responses are irregular. Slight exercise, however, in flutter, usually renders the ventricular rhythm regular, with a definite grade of heart-block, such as 3:1 or 2:1. This does not occur in atrial fibrillation.

Course and Complications. Paroxysms of flutter may occur, or a continuous stage may persist for as long as 10 years. Paroxysms may ensue, in which the ventricle assumes the atrial rate. These are very dangerous, the patient rapidly losing consciousness and dying. Congestive heart failure may occur as a complication of flutter.

Prognosis. This is always serious, but not usually immediately grave. The condition of the myocardium is a factor of great importance, although hard to estimate.

Treatment. The patient should be put to bed and digitalised, as for fibrillation. This usually converts the flutter rhythm to that of fibrillation. On stopping the digitalis a normal rhythm may ensue.

Ventricular Fibrillation

This is probably the cause of sudden death in coronary obstruction, complete heart block, diphtheritic myocarditis, and following the intravenous injection of mercurial diuretics. It is compatible with life only if the fibrillation is of very short duration, the clinical picture then being that of Stokes-Adams attacks. Cardiac resuscitation methods of treatment should be given as described on p. 252.

Heart-block

Definition. A condition characterised by delay in the conduction of impulses along some portion of the junctional tissue of the heart. The following varieties are described: 1. Sino-atrial block. 2. Ventricular block. 3. Bundle-branch block. 4. Arborisation block.

Etiology. Congenital heart-block is due to a defect, such as a patent ventricular septum interrupting the bundle of His, or rarely to aortopulmonary patency. Acquired heart-block may be due to inflammatory

branch block the second heart sound may be split. It is of grave significance, death often occurring within three years of its detection, but the prognosis depends upon the associated heart disease. Right bundle-branch block in an otherwise healthy individual is not of serious significance. Stokes-Adams attacks have also been described in bundle-branch block.

The Wolff-Parkinson-White Syndrome

The condition was originally described as bundle-branch block, but is now thought to be due to "pre-excitation" or to "accelerated conduction." This means that the impulse, instead of being delayed in its passage from atrium to ventricle, is accelerated. The impulse may pass along an abnormal pathway from atrium to ventricle, which was described by Kent as "the right lateral bundle," thus reaching the right ventricle before arriving at the left ventricle. Alternatively, the impulse may travel along the normal path from atrium to ventricle, but its passage through a portion of the A-V node may be accelerated. The Wolff-Parkinson-White syndrome is characterised electrocardiographically by (a) Shortening of the P-R interval, usually to 0.12 second or less. (b) Widening of the QRS complex, with slurring at its onset. The P-S interval is normal. (c) Changes in the direction of the QRS complex, with right or left axis deviation. (d) Changes in the S-T segment and T waves. (e) Paroxysmal supraventricular tachycardia, atrial extrasystoles, atrial flutter or fibrillation.

Clinical Findings. Paroxysmal tachycardia occurs in about 50% of the patients, especially after exercise. It generally shows itself before the age of 30, and males are more often affected than females. It is usually benign, but sudden death may occur.

Treatment. Quinidine in a dose of 3 gr. (0.2 G.) by mouth may produce a sudden and dramatic improvement. It must be given cautiously as the patient may be sensitive to quinidine. Subsequently a small maintenance dose, such as 3 gr. (0.2 G.) daily, may be required.

Arborisation Block

The terminal subendothelial divisions of Purkinje's fibres have impaired conductivity. This lesion can be detected by an electrocardiogram. The prognosis is usually bad.

Pulsus Alternans

Definition. Alternate strong and weak contractions of the ventricles.

Etiology. Pulsus alternans is probably a manifestation of myocardial degeneration, the heart labouring against an excessive burden; it may also result from an overdose of digitalis.

Clinical Findings. Pulsus alternans is difficult to detect by the finger. A radial tracing will, however, show alternate large and small beats at very nearly regular intervals. If the blood pressure is taken by the auscultatory method, only alternate beats will be heard at higher pressures, whereas on lowering the pressure in the armlet each beat will be audible. An electrocardiogram may show R waves of

corresponding in rate with the atrial contractions, and so faster than the apex beat or radial pulse.

Differential Diagnosis. Clinically the missed beats which occur at the wrist in heart-block must be distinguished from those resulting from feeble premature systoles. In the former, as described above, there is silence on listening over the heart, when the beat is absent at the wrist. Inhalation of amyl nitrite in 2 : 1 heart-block will often suddenly double the rate of the pulse, the apex subsequently abruptly reverting to its slow rate. This change does not occur in simple bradycardia. The ventricular rate in complete heart-block is not affected by exercise or by the inhalation of amyl nitrite, or by the injection of atropine sulphate.

Course and Complications. Heart-block, especially in the young, when arising during the course of, or in convalescence from an acute illness, is usually a temporary derangement. If due to a degenerative lesion, it is likely to be permanent. With the stage of onset of complete block, the Stokes-Adams syndrome is to be feared.

Prognosis. Heart-block always indicates some degree of myocardial abnormality, due either to an inflammatory lesion, which may be temporary, or to a permanent degenerative one. The outlook is more serious when complicated by Stokes-Adams attacks.

Treatment. When heart-block develops during the course of an infective illness, the patient should be kept strictly at rest in bed until the normal rhythm is restored, or until it is considered that the heart-block is permanent. In other cases the Wassermann reaction should be determined, and, if positive, a course of anti-syphilitic treatment given (see p. 600). For Stokes-Adams attacks subcutaneous injection of 8 m. (0.5 ml) of inject. adrenaline (B.P.) 1 in 1,000 should be given immediately, followed by ephedrine sulphate, $\frac{1}{2}$ gr. (30 mg.) t.d.s. by mouth, or by sustained action isoprenaline (Saventrine) 30 mg. tab. 8-hourly, increasing by 1 tab. a day up to 4 tabs. 6-hourly. Saventrine may aggravate Stokes-Adams attacks when they are due to ventricular arrhythmias. Attempts at cardiac resuscitation should be carried out as described on p. 252.

In cases of permanent heart-block, resistant to medical treatment, an electrical pacemaker may be used. There are several varieties, such as the endocardial-jugular pacing with an external pacemaker. The electrode catheter is inserted into the right ventricle via the jugular vein, the tip being "wedged" into the apex of the ventricle. The positive electrodes are buried in the subcutaneous tissues of the chest wall. Both electrodes are connected to an external pacemaker powered by mercury batteries. The pacemaker is adjusted to give 65 to 75 impulses per minute. The patient is liable to displace the electrode catheter. The average duration of life of the pacemaker is just over a year.

Bundle-branch Block

There is delay in conduction in one or other of the branches of the bundle of His, leading to the left or right ventricle. This condition can only be diagnosed by means of an electrocardiogram. In left bundle-branch block the first heart sound may be split, and in right bundle-

rare condition, which usually results in death in less than a year. *Dilatation*: This may be due to fatty degeneration, to acute inflammatory changes, or it may be associated with hypertrophy. *Inflammation*: Acute simple myocarditis. This occurs in infections, especially rheumatic fever, and diphtheria, and less often with typhoid or scarlet fever, septicæmia, Graves' disease, and syphilis. Acute suppurative myocarditis. Small embolic abscesses may form in the myocardium in pyæmia, as in puerperal fever, osteomyelitis or malignant endocarditis. *Vascular degeneration and infarct*: These are especially associated with coronary obstruction. *Rupture*: This may follow an infarct or result from penetrating injuries, or occasionally from non-penetrating injuries of the chest wall.

Sudden death from fatty heart is due probably to ventricular fibrillation, and not to the fat around the heart. Fatty degeneration of the heart, however, such as occurs in diphtheria, leads to cardiac dilatation, tic-tac rhythm, and irregularities such as heart-block or gallop rhythm. It is a very serious condition. Fibroid heart is often described as a condition of hypertrophy of the left ventricle, such as is found in hypertensive heart disease.

Alcoholic Cardiac Myopathy

This is associated with excessive alcohol intake over long periods. It occurs chiefly in men and presents the usual features of heart failure. Patchy areas of fibrosis are found in the myocardium, with hypertrophy of the left ventricle, and dilatation of the right ventricle and atria.

Hypertensive Heart Disease

Definition. Hypertrophy of the left ventricle due to hyperpiesia.

Etiology. The cardiac enlargement is secondary to the high blood pressure. The cause of the high blood pressure (essential hypertension) is unknown, but the subject is discussed on p. 283.

Pathology. There is hypertrophy of the heart. The left ventricle is chiefly affected. The muscle fibres are increased in size.

Clinical Findings. The patient is usually an adult over the age of 40. He complains of symptoms due to high blood pressure (see p. 285). No cardiac symptoms are noticed until the reserve of cardiac power is overtaxed, or some complication such as disturbance of coronary circulation occurs. Symptoms include shortness of breath on exertion, attacks of cardiac asthma, palpitations or præcordial pain.

On Examination: The heart. The apex beat is usually displaced downwards and outwards. A systolic murmur may be heard at the apex, due to mitral regurgitation and occasionally there is an aortic systolic or diastolic murmur. With failure of the heart, pulsus alternans or presystolic gallop rhythm (see p. 241) may be present. The blood pressure, which is raised in the early stages of the disease, often falls with the onset of failure of compensation, although the diastolic figure

equal intensity, although the radial tracing shows definite alternation. Pulsus alternans can be differentiated from premature systoles regularly recurring with every other beat (pulsus bigeminus) by the short interval between the normal and successive premature beat, and the longer interval between the premature beat and the next normal one. The condition is of grave import when occurring in a pulse of normal rate, but if associated with paroxysmal tachycardia or with digitalis medication the prognosis is not so serious.

Pulsus Paradoxus

Definition. A condition in which the pulse weakens in intensity with inspiration and becomes stronger with expiration.

Etiology. Pulsus paradoxus is often associated with mediastinopericarditis and with pericardial effusion, and may be explained by the fact that normally during inspiration the roots of the lungs descend and carry the heart with them. If, however, the heart is tethered by adhesions, or pressed on by a pericardial effusion, during inspiration it is pulled on from above and below. The orifices of the venæ cavæ will then be partially obstructed, with diminished cardiac inflow and output.

THE MYOCARDIUM

The pathological affections of the myocardium may be grouped as follows: *Atrophy*. *Cloudy swelling*. *Fatty degeneration and infiltration*. *Fibrosis*. *Amyloid, hyaline and calcareous degenerations*. *Granulomata*. *Tumours, simple and malignant*. *Cysts*. *Hypertrophy*. *Dilatation*. *Inflammation*. *Vascular degeneration and infarct*. *Rupture*.

Atrophy: This is usually a brown atrophy. It is common in old age and in wasting diseases, such as tuberculosis and cancer. *Cloudy swelling*: This is met with in acute fevers and septicæmia. *Fatty degeneration*: This occurs in acute fevers, diphtheria, alcohol, chloroform or phosphorus poisoning, and in blood diseases, such as anæmia and leukæmia. It causes the change known as "tabby cat" striation or "thrush's breast" appearance, seen under the endocardium, usually in the left ventricle. *Fatty infiltration*: This is sometimes, but not invariably, associated with obesity. *Fibrosis*: This is associated with arteriosclerosis and narrowing of the coronary arteries. The areas of fibrosis may be localised or diffuse, and are commonly found in the left ventricle. It may occur diffusely, as a sequel of rheumatic carditis. *Amyloid, hyaline and calcareous degenerations*: These are less common. *Granulomata*: These include syphilis and tuberculosis of the heart. *Tumours*: A lipoma, fibroma, a pedunculated atrial myxoma or a rhabdomyosarcoma may develop, or secondary melanotic sarcoma or rarely secondary carcinoma. *Cysts*: A hydatid may form in the heart. *Hypertrophy*: This is associated with valvular disease, such as aortic or mitral regurgitation, with adherent pericardium, increased blood pressure (hypertensive heart disease), thyrotoxicosis, chronic nephritis and arteriosclerosis. The normal weight of the heart is 0.4% of the body weight. Congenital idiopathic hypertrophy is a

(6) Diffuse changes in the pulmonary arteries or arterioles, resulting in pulmonary arteriosclerosis. (7) Some varieties of congenital heart disease, such as patent ductus arteriosus, and atrial and ventricular septal defects.

When the pulmonary arterial pressure rises to about 60/30 mm. Hg. early signs of *cor pulmonale* appear.

Acute cor pulmonale. This may be due either to massive pulmonary embolism, or to an attack of pneumonia occurring in a patient suffering from severe emphysema.

Chronic cor pulmonale. The more common causes are emphysema, and bronchitis with spasm. Other lung causes include pulmonary fibrosis, pneumoconiosis, carcinomatosis, schistosomiasis, tuberculosis, bronchiectasis, and cysts of the lungs. Among arterial causes are pressure by an aneurysm on the main pulmonary arteries, pulmonary arteriosclerosis and cicatricial pulmonary arteritis. Kyphoscoliosis is also a cause in some cases.

Ayerza's disease is a term which some authorities consider should be abandoned. The cyanosis (*cardiacos negros*) was due in the original case to long-standing diseases of the lungs, and was an example of chronic *cor pulmonale*.

Clinical Findings. In *acute cor pulmonale* the symptoms are those of massive pulmonary embolus; dyspnoea, distress and collapse being very marked.

In *chronic cor pulmonale* the patient complains of progressively increasing dyspnoea, followed by cough, expectoration, and sometimes hæmoptysis. Lack of concentration, giddiness, palpitations and somnolence may also be noticed.

On Examination: In *acute cor pulmonale* there is cyanosis with venous engorgement in the neck. The pulse is very feeble and rapid, and the dyspnoea intense. The pulmonary second sound is accentuated and protodiastolic gallop rhythm may be present. The patient usually rapidly loses consciousness and dies. In *chronic cor pulmonale* signs of right-sided cardiac failure are present; cyanosis, dyspnoea, tachycardia, and low blood pressure. The heart dulness is enlarged to the right and left, if it is not obscured by emphysema. The increase in dulness is due to the right atrial dulness extending to the right, and the right ventricular dulness to the left. A systolic murmur is sometimes heard over the tricuspid area. An electrocardiogram will show right axis deviation with tall P waves and inverted T waves in leads II and III, and an X-ray examination will reveal the enlargement of the right atrium and right ventricle. In more advanced cases the veins of the neck are engorged, the liver enlarged, tender and pulsating, and there is œdema of the legs. A transudate may form in the pleural sacs, usually more on the right side, and there may be hydropericardium. Recurrent attacks of papilloedema may be noted, varying with the degree of heart failure.

Treatment. *Acute cor pulmonale.* The patient should lie propped up, and oxygen should be administered through a mask. Removal of a pint (600 ml.) of blood from a vein in the arm may afford considerable

generally remains over 100 mm. Hg. Ophthalmoscopic examination may show retinal arteriosclerosis.

Differential Diagnosis. Hypertensive heart disease must be differentiated from cardiac enlargement associated with chronic nephritis, or due to aortic disease or thyrotoxicosis. The diagnosis is difficult in the later stages, especially if the blood pressure has fallen.

Course and Complications. The course is progressive. Complications include atrial fibrillation, congestive heart failure, cerebral hæmorrhage, angina pectoris, coronary thrombosis, and rarely uræmia. Intercurrent infections are not uncommon.

Prognosis. This is always unfavourable, especially when there is marked cardiac enlargement, retinal arteriosclerosis, or myocardial failure.

Treatment. This is as described for hyperpiesia and for congestive failure (see pp. 285, 243).

Endomyocardial Fibrosis

(*Endocardial Fibro-elastosis*)

Fibrotic thickening of the ventricular endothelium may occur as a congenital lesion or be associated with cardiac infarction or rheumatic carditis. Non-arteriosclerotic endomyocardial fibrosis is of widespread distribution.

In Africa, where it is responsible for about a third of all cases of heart failure, it is met with apart from the above conditions. The cause is not known, it does not appear to be associated with malnutrition, but it may result from sensitisation to streptococcal products or to eating large quantities of bananas which contain 5-hydroxytryptamine in considerable amounts. There is thickening and fibrosis of the endocardium near the apex of the left ventricle and the mitral valve may also be thickened. The right ventricle and tricuspid valve may also be affected.

Pulmonary Heart Disease

(*Cor Pulmonale*)

Definition. Enlargement of the right ventricle due to rise of pulmonary arterial tension.

Etiology. The normal pulmonary arterial pressure is between 18 and 80 mm. Hg. systolic and 7 to 10 mm. Hg. diastolic. Rise of pressure in the pulmonary artery may be due to (1) Left ventricular failure and mitral disease. (2) A diminution in the vascular channels in the pulmonary bed, owing to such conditions as emphysema or fibrosis of the lungs. Living at a high altitude may cause pulmonary hypertension, possibly due to thrombosis of the smaller pulmonary arteries. (3) Loss of areas of lung tissue, as occurs in tuberculosis, after resection of the lung, etc. (4) Obstruction of pulmonary arterioles by multiple emboli. (5) Thrombosis of the major pulmonary arteries.

been mentioned in the article on Pulmonary Heart Disease. In Bernheim's syndrome, or isolated right heart failure, there is systemic venous engorgement without pulmonary congestion. It is associated with hypertrophy and dilatation of the left ventricle due to hypertension, kidney disease, or combined aortic and mitral valvular lesions. The patient dies with the classical features of right-sided failure, and at autopsy the right ventricle is found to be stenosed as the result of encroachment in the right ventricular space of the hypertrophied ventricular septum. The arm-to-tongue circulation time is generally normal, and, despite the raised venous pressure and œdema, the patient can often lie flat in bed without distress. 3. *Left and right heart failure.* This may be associated with rheumatic carditis, diphtheria, severe anæmia, generalised coronary arteriosclerosis, atrial fibrillation, atrial flutter, paroxysmal tachycardia, hyperthyroidism and constrictive pericarditis.

Heart failure may be acute or insidious; for example, acute left heart failure may follow hypertension, aortic disease or coronary occlusion, and acute right failure may be associated with pulmonary embolus, thrombosis or lobar pneumonia.

Clinical Findings. *Left heart failure.* Three stages are described: (a) Paroxysmal pulmonary congestion. Attacks of acute œdema of the lungs or of nocturnal dyspnoea occur, with cough and lesser degrees of pulmonary œdema. (b) Pulmonary congestion of effort. Here shortness of breath, cough and often blood-stained sputum are provoked by exercise, excitement or a cold atmosphere. (c) Chronic pulmonary congestion. This is characterised by shortness of breath and at times hæmoptysis. Such cases are liable to be mistaken for chronic bronchitis, pulmonary tuberculosis or a new growth.

The chief clinical features of left heart failure are pallor with some cyanosis, and dyspnoea especially on effort and at night. The heart is usually enlarged to the left, and gallop rhythm or pulsus alternans may be present. With gallop rhythm a third heart sound is heard during mid or late diastole, the heart sounds are then likened to the sound produced by saying "lub lub dupp." Graphic records indicate that the first part of the sound occurs in presystole and is presumably atrial in origin. It is also known as presystolic gallop rhythm, the extra sound perhaps being due to vibrations of a rapidly filling ventricle which lacks tone. It does not occur in atrial fibrillation. This third sound can also be felt as a diastolic impulse. The three heart sounds are evenly spaced, and the third sound is only heard when the rate is rapid. It is of very grave significance. Presystolic gallop must be distinguished from protodiastolic gallop rhythm. In the latter a third sound closely follows the second sound, "lub dupp dupp." This is of no significance, being an accentuation of the physiological third heart sound. It is best heard near the apex of the heart, whereas a split second sound is most noticeable near the base. The blood pressure is usually high, especially the diastolic figure, and the rhythm is usually regular, but premature systoles or paroxysmal atrial fibrillation may occur. Rûles are heard at the bases of the lungs and a hydrothorax may develop, more frequently

relief. Ten ml. of nikethamide (Coramine) or 1 mg. of strophanthin-K may be injected intravenously, or an intravenous injection given of 250 mg. aminophylline in 10 ml. sterile saline.

Chronic cor pulmonale. Oxygen should be administered cautiously as described under emphysema on p. 175. The heart failure should be treated with digitalis, diuretics, and a low salt diet. Pulmonary infection and bronchospasm should be treated as described in the section dealing with respiratory disorders. Morphine should not be administered, but rest and sleep may be secured by the administration of paraldehyde, 60 to 120 m. (4 to 8 ml.) by mouth in 30 m. (2 ml.) capsules, or by an intramuscular injection of paraldehyde, 5 to 10 ml. (10 ml. ampoules).

Primary Pulmonary Hypertension

This is a rare disease in which there is obstruction of the smaller pulmonary arteries by endarteritis fibrosa. The cause is unknown. Adults and children may be affected. The patient complains of lassitude, dizziness, fainting attacks, pains in the chest and shortness of breath. Cyanosis is often marked, with polycythæmia. The extremities are pale. There is enlargement of the right side of the heart and the electrocardiogram shows right ventricular hypertrophy. Cardiac catheterisation reveals a rise of pressure in the right ventricle to perhaps 50 mm. Hg. (normal about 25 mm. Hg.).

The Failing Heart (Congestive Heart Failure)

Pathogenesis. The exact nature of heart failure is still uncertain. It is probable that left ventricular failure causes dilatation and incompetence of the mitral valve, with resultant congestion of the lungs, and, subsequently, secondary failure of the right ventricle and dilatation of the tricuspid valve lead to systemic congestion. Observations made by cardiac catheterisation indicate that in congestive heart failure there is a rise in venous pressure which results in overloading of the heart. Further rise in the venous pressure results in diminished cardiac output. Heart failure may thus affect either side of the heart independently, or both sides may be involved simultaneously. Further, such failure may be acute or insidious in onset. From what has been said above, it will be clear that we should expect to find systemic congestion with right-sided failure and pulmonary congestion with left-sided failure.

Etiology. 1. *Left heart failure.* This is approximately three times as common as right heart failure. The important causes are hypertensive heart disease, aortic stenosis, aortic regurgitation, chronic nephritis and coronary occlusion. 2. *Right heart failure.* This is most frequently secondary to left heart failure. Other important causes have

pressure and increases the cardiac output in low output failure. In high output failure digitalis, by lowering the cardiac output, does not appear likely to produce clinical improvement.

Treatment. Acute Left Heart Failure. If there is œdema of the lungs an injection of morphin. sulph. $\frac{1}{2}$ gr. (20 mg.) and atropin. sulph. $\frac{1}{50}$ gr. (1.2 mg.) should be given. This should be followed by venesection of 15 to 20 fl. oz. (450 to 600 ml.). Digitalis in large doses is indicated in other cases, or to produce a rapid effect an intravenous injection of strophanthin 1/200 gr. (0.8 mg.) or of ouabain 1 mg. should be given.

Acute Right Heart Failure. This has been described on p. 239.

Routine Treatment of Heart Failure. The patient should be in bed, on absolute rest, propped up in the most comfortable position. He may obtain relief by leaning forward on a well-padded heart table, placed across the bed. Diet: The meals should be taken dry and not more than 30 fl. oz. (900 ml.) of fluid drunk in the 24 hours. The total calorie value should be low, 800 to 1,000 calories. A low salt, low calorie diet should be given containing about 500 mg. Na with a calorie value of 1,000. Breakfast: One egg. Salt-free bread 1 oz. (30 G.) or Motza biscuit $\frac{1}{2}$ oz. (15 G.). Butter, from daily allowance. Tea, with milk from daily allowance. Sugar, one teaspoonful. Fresh fruit 4 oz. (120 G.). Mid-morning: Tea with milk from allowance. Lunch: Lean meat or fish, 2 oz. (60 G.). Green vegetables or root vegetables, as desired. Stewed fruit, 4 oz. (120 G.). Tea: Tea, with milk from allowance. Salt-free bread, 1 oz. (30 G.) or Motza biscuit, $\frac{1}{2}$ oz. (15 G.). Butter from allowance. Dinner: One egg, or lean meat or fish, as at lunch. Green vegetables or salad. Fresh or stewed fruit. Salt-free bread, 1 oz. (30 G.) or Motza biscuit, $\frac{1}{2}$ oz. (15 G.) Butter from allowance. Daily allowance: Unsalted butter or margarine, $\frac{1}{2}$ oz. (15 G.). Milk, 10 fl. oz. (300 ml.). The amount of urine passed every 24 hours should be measured and charted. Digitalis should be given as described for atrial fibrillation (see p. 231) keeping a watch for the onset of toxic symptoms, such as nausea, vomiting, oliguria, bradycardia or coupled beats. Digitalis may be given if the patient is suffering from heart-block. There is a danger in giving digitalis to elderly patients, especially if they are taking thiazide diuretics. The pulse rate may increase with cardiac arrhythmia, aggravation of cardiac failure and mental confusion. A dose of 0.25 mg. digoxin every second or third day may be sufficient, or a Lanoxin-PG tab. containing 0.0625 mg. digoxin may be given daily.

Diuretics should also be given such as chlorothiazide and hydrochlorothiazide. It is important to give potassium chloride with these preparations when digitalis is being simultaneously administered, in order to avoid the danger of ventricular tachycardia and cardiac arrest. Chlorothiazide can be administered as Saluric, 0.5 G. tab., 2 tabs. before breakfast and lunch, 2 to 3 consecutive days a week, together with potassium chloride, 0.5 G. tab., 2 tabs. t.i.d. with meals for 2 to 3 days after the Saluric. Hydrochlorothiazide is more potent. It is put up as Hydrosaluric tab. 50 mg. Two to four tabs. may be given in the morning on alternate days, together with potassium chloride, as above. Potassium chloride should not be combined with thiazide preparations

on the left side, and, if bilateral, it is usually larger on the left side. It is sometimes interlobar. The electrocardiogram often shows left axis deviation inverted T_1 , or T_1 and T_2 waves, or there may be bundle-branch block. X-ray examination shows that the pulmonary arterial shadows are unduly dense and enlarged, and a blurred zone around the pulmonary roots indicates the onset of pulmonary oedema. If right-sided failure now supervenes the symptoms of pulmonary congestion are, to a certain extent, relieved, and paroxysms of dyspnoea usually cease. The attacks of nocturnal dyspnoea are often known as *cardiac asthma* and they may be associated with bronchial spasm. The patient wakes up suddenly, feels suffocated, sits up, struggles for breath, and finally he may fall back exhausted and sweating. The attacks may be more severe, the patient having acute oedema of the lungs. Cheyne-Stokes breathing is seen in other cases, the breathing waxing and waning, with intervals of apnoea lasting 30 or 40 seconds. During the hyperpnoeic period which results from stimulation of the respiratory centre, CO_2 is washed out of the blood. This produces the apnoeic phase. The patient may sleep in the apnoeic phase and wake with each period of hyperpnoea.

Right heart failure. This has been described under Pulmonary Heart Disease.

The determination of the arm-to-tongue circulation rate and of the systemic venous blood pressure affords further evidence of left or right ventricular failure. With left ventricular failure the arm-to-tongue circulation time is increased but the systemic venous pressure is usually normal; whereas with right ventricular failure both the circulation time and the venous pressure are increased.

The circulation rate. The arm-to-tongue circulation rate is used to determine the rate of circulation through the lungs. The normal time is between 10 and 17 seconds. In heart failure it may be increased to 40 seconds or more.

The systemic venous blood pressure. This can be gauged clinically by observing the cervical veins with the patient recumbent and propped up. Normally the venous pressure is zero at the point in the vein which is in the same horizontal plane as the lower end of the sternum. With an increase of venous pressure the cervical veins on both sides will be engorged at a point which is on a plane higher than that of the manubrium zero level. An increased systemic venous pressure is almost certainly present if the cervical veins are dilated when the patient is propped up at 45° .

Catheterisation of the Right Atrium. Catheterisation of the right atrium, by inserting the catheter into the basilic vein in the left arm and passing it into the right atrium, has indicated that heart failure may occur either with a high or a low output. The normal cardiac output is 5 litres a minute. In severe anaemia the cardiac output may reach 12 to 14 litres a minute, the venous pressure then rising. A high output also occurs in emphysema and in Paget's disease, owing to the highly vascular state of the bones in the latter condition. Heart failure in valvular, arteriosclerotic and hypertensive heart disease, is associated with an output as low as 3 litres a minute. Digitalis lowers the venous

Peripheral Circulatory Failure

The circulation may fail primarily in the periphery rather than in the heart. This is due to slowing of the circulation caused by dilatation of the arterioles, so that there is failure of the venous return to the heart and diminished cardiac output. It is met with typically in surgical shock, but may occur in acute infections such as diphtheria or pneumonia. The blood pressure is very low. The pulse is regular but very feeble, the skin is pale and cold, but the heart beat is forcible. In pneumonia the blood may be pooled in the skin, giving rise to cyanosis. Treatment of peripheral failure is often unsatisfactory. Ephedrine hydrochlor. $\frac{1}{2}$ gr. (30 mg.) should be given by mouth and Pitressin 1 ml. (20 units) injected intramuscularly every 6 hours, and an intramuscular injection of nikethamide (Coramine) 2 ml. given t.i.d. The foot of the bed should be raised and hot bottles applied to the patient's feet.

Syncopal Attacks

Definition. Unconsciousness due to deficient cerebral circulation.

Etiology. The circulatory failure may be primarily vascular due to deficient supply of blood to the heart, or primarily cardiac due to deficient output from the heart.

The chief causes are thus anæmia, low blood pressure, change of posture, vaso-vagal attacks, an over-active carotid sinus reflex, heart-block and atrial flutter.

Clinical Findings. The clinical findings are described under the respective headings of the causative conditions. Postural syncope does not occur when the patient is lying. In all syncopal attacks, as opposed to fainting attacks of cerebral origin and not due to disordered cerebral circulation, the pulse is weak. An unduly sensitive carotid sinus reflex results in reflex vagal stimulation and slowing of the heart. It occurs especially with a raised blood pressure and arteriosclerosis. Pressure over one or other carotid sinus may slow the heart and produce an attack of syncope in those predisposed.

Treatment. This is described under the respective headings. A hypodermic injection of atropin. sulph. 1/100 gr. (0.6 mg.) or of 5 m. (0.3 ml.) of inject. adrenaline (B.P.) 1 in 1,000 will usually relieve vaso-vagal attacks. For carotid sinus syncope ephedrine sulph. $\frac{1}{2}$ gr. (45 mg.) t.d.s. by mouth may afford relief, and in severe cases denervation of the sinus has been performed.

Ischæmic Heart Disease

This is the name sometimes given to the condition associated with deficient circulation through the coronary arteries. It may result from various causes such as aortic stenosis, atheroma of the coronary arteries, thrombosis of the smaller branches of the coronary arteries without infarct formation, anæmia, and thyrotoxicosis. In old age areas of fibrosis may develop in the myocardium.

in an enteric-coated centre. When liberated in the small intestine the potassium may cause stricture, obstruction or perforation. The potassium chloride should be prescribed separately, as deficiency of potassium is a serious factor in progressive heart failure.

Frusemide (Lasix) tab. 40 mg., in doses of 40 to 120 mg., produces a good diuresis with elimination of sodium. It can be taken at tea-time and there is no need to prescribe potassium.

Diuresis may also be produced by aldosterone antagonists, especially by spironolactone. Excessive production of aldosterone which causes retention of sodium, (see p. 711), is thought to be a factor in the production of œdema in congestive heart failure, nephrosis and cirrhosis of the liver. Spironolactone (Aldactone-A), 25 mg. tab., may be given in doses of 4 tabs. daily for 5 days or more. Spironolactone prevents loss of potassium which occurs with the chlorothiazide group of drugs, and may be used with them instead of giving potassium chloride by mouth. Aminophylline (Cardophyllin) can also be used as a diuretic and to dilate the coronary vessels. It can be given by mouth as a tablet (0.1 G.), two to four daily, or as an intravenous injection of 250 mg. in 10 ml. daily, or as an intramuscular injection of 500 mg. in 2. ml. daily. A hydrothorax should be aspirated, as it severely impedes the heart's action; similarly ascitic fluid should be removed by drainage if it does not show signs of absorption. If the œdema persists in the legs it is advisable to sit the patient up in a heart chair for 12 hours and then drain the legs, by making multiple small incisions, $\frac{1}{4}$ inch (6.2 mm.) long, through the skin, which has been sterilised with ether, on the dorsum of the feet and lower part of the front of the legs. The legs are then covered with sterile gauze, which is changed as it becomes soaked with the fluid, the legs being further protected by a cradle covered with a blanket. The gauze usually requires changing every 3 or 4 hours. Venesection should be performed for right-sided engorgement and oxygen administered. Sleep should be secured either by the use of 30 gr. (1.8 G.) chloralamide in a mixture, or by dichloralphenazone (Welldorm) 650 mg. tab., 1 or 2 tabs. nocte., or by nepenthe 15 m. (1 ml.) with aspirin 10 gr. (0.6 G.), or by a subcutaneous injection of morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.) with atropin. sulph. 1/120 gr. (0.5 mg.) nocte. For cardiac asthma an injection of Omnopon $\frac{1}{2}$ gr. (20 mg.) may be given. Frusemide (Lasix), 40 mg. tab., taken at tea-time may prevent nocturnal cardiac asthma. In some cases which have failed to respond to treatment the administration of prednisone 5 mg. tab., 1 tab. t.d.s. in addition to digitalis, diuretics and a low salt diet, has produced striking results.

The After Treatment. The patient must be kept in bed until the pulse rate remains steady at about 80. He may then be allowed to sit out of bed for half to one hour daily, and subsequently gradually walk about on the level. The fluid intake should be restricted to 30 to 40 fl. oz. (900 to 1,200 ml.) in the 24 hours. Saluric with potassium chloride or frusemide (Lasix) may be given one or two days a week. During this period of convalescence massage to the extremities and the body is of great value. The walking exercise should be carefully regulated, and the patient should sit down immediately he experiences any cardiac distress.

usually begins in the mid-line behind the sternum, and may radiate thence to the left shoulder, down the ulnar side of the left arm, to the left side of the neck and jaw, or to the scalp. I have seen a case in which it was only felt in the jaw, in others it remains localised to the back or wrist. Often the pain radiates to the right side also. In some instances the pain is first felt in the region of the xiphoid process or epigastrium (abdominal angina), or in the arteries of the arm. The pain is very severe, continuous while it lasts, and non-throbbing. A sense of constriction, as if the chest were held in a vice, is also felt simultaneously with, or shortly after the pain. This is probably due to contraction of the intercostal muscles. The attack is sometimes accompanied by severe mental anguish and by a sensation of impending death. This is more likely to occur with spasmodic angina. The attack may last for only a second or for several minutes, in some instances a *status anginosus* ensues in which a series of attacks rapidly follow one another. *Angina sine dolore* is also described, in which the patient is suddenly seized by a sensation of imminent death, becomes pale and motionless, and yet experiences no pain. During the attack salivation or vomiting may occur, the attack ceasing with eructation of wind, or a copious flow of urine. Minor attacks vary in severity from slight substernal distress on exertion to definite pain.

Examination of the Patient During the Attack. He is usually pale, motionless, and silent; he may, however, be flushed or groan. Frequently the pulse is unaffected, but at times it is feeble. The blood pressure usually rises, and may reach a figure of 340 mm. Hg. syst.; in some instances it is not affected. Sudden death may occur during the attack, perhaps from vagal inhibition or from ventricular fibrillation. The heart may show no abnormality clinically, or there may be enlargement. When the examination is made between the attacks, cardio-vascular degeneration is usually found with arteriosclerosis and increased blood pressure, and shortly after an attack tender spots are often present over the præcordium or along the arm. The electrocardiogram between the attacks is usually normal. During or immediately after an attack, or if the patient exercises sufficiently to produce pain, the electrocardiogram shows in about 90% of cases, depression of the RS-T segment in the majority of leads.

Differential Diagnosis. Angina must be differentiated from : 1. Left inframammary pain. 2. Coronary thrombosis. 3. Intercostal pain from other causes. 4. Biliary and intestinal colic. 5. The scalenus anterior syndrome. 6. Diaphragmatic hernia. 7. Oesophageal spasm.

1. Left inframammary pain. The pain is usually a dull ache, but it may be very severe. It is situated near the apex of the heart and may radiate to the left arm or shoulder. It is present apart from exercise, but is frequently accentuated by exercise. The patient is often a woman suffering from a chronic anxiety state. In addition to the pain she may complain of feeling tired, of attacks of sighing respiration, trembling and sweating. No sign of disease of the heart or arteries can be detected.

2. Coronary thrombosis. The differential diagnosis is considered on p. 251.

Angina Pectoris

Definition. A condition characterised by paroxysmal attacks of substernal pain, of grave prognosis, and often associated with changes in the aorta, heart or coronary arteries.

Etiology. It is now generally believed that in angina the pain impulses arise in the heart muscle as the result of interference with its blood supply. Myocardial ischæmia produces pain, possibly owing to anoxia, possibly as the result of retention of a pain-producing factor liberated by muscular contraction and retained locally owing to deficient circulation. The deficient blood supply may be due to disease, obstruction or spasm of the coronary arteries. Further, in some cases anginal symptoms are associated with severe anæmia, diabetes mellitus, spontaneous hypoglycæmia, hyperthyroidism and hypothyroidism. Angina is not, however, a regular accompaniment of these diseases; there must therefore be some other causative factor than diminished oxygen or sugar supply to the heart muscle, impaired coronary filling or low muscle metabolism. The additional factor in those cases in which angina is present may be coronary narrowing due to lesser degrees of disease or spasm. *Exciting causes* include muscular exercise which is the characteristic instigator of *angina of effort*, and exposure to cold, mental exertion and excitement, anger, a heavy meal and possibly over-indulgence in tobacco, which lead to coronary spasm and *spasmodic angina*. John Hunter died from angina during an angry Board Meeting at St. George's Hospital, London, in 1768. Angina was often associated with syphilis, but it may follow an acute illness such as influenza, malaria or rheumatic fever. It tends to run in families and is more common in men, especially after the age of 50. Brain workers are liable to angina.

Pathology. The coronary arteries are usually diseased, showing either calcification, endarteritis, or occlusion of their orifice by aortitis or atheroma of the aorta. The aorta is often affected; syphilitic aortitis, atheroma or aneurysm may be present. The myocardium is frequently diseased. If the patient dies in an attack, the heart is usually relaxed and full of blood. Ischæmic fibrosis is often found, resulting from obliterative arteritis of the coronary vessels.

Clinical Findings. The patient is usually a man over the age of 50. Angina less frequently affects women, and young people may suffer from it as the result of syphilis or an acute illness, such as influenza. In *angina of effort* the patient complains of attacks of pain which have usually a sudden onset and cessation, and are provoked by exertion, which may, however, only be of a very slight degree, such as walking a few yards, or in more severe cases, turning over in bed or talking. The characteristic feature is that in each case there is a direct and often a quantitative relationship between exercise and the onset and the severity of cardiac pain. With rest the pain is rapidly relieved. Attacks of *spasmodic angina* occur apart from exercise. Further, angina of effort and spasmodic angina may occur simultaneously or consecutively. The attack of spasmodic angina does not cease with rest and tends to run its course unless relieved by drugs. The pain

and be given a short course of anticoagulants (see p. 191). In the majority of cases of angina it is not necessary for the patient to take to his bed. The pain can often be warded off by a trinitrin tablet before the patient goes out in the morning. Peritrate has a more prolonged action than nitroglycerin. It is given by mouth, 10 mg. tab., 1 or 2 before meals and at bedtime. A sustained action Peritrate tablet, 80 mg., is also available, the dose being one every 12 hours. Smoking should be given up if it is found that it is a causative factor. Nicotine dilates coronary arteries, but it may liberate noradrenaline from stores in or near the walls of the blood vessels and produce angina by increasing the work of the heart. Alcohol in moderation is not harmful. For the nervous excitability which is so frequently present, phenobarbitonum $\frac{1}{4}$ gr. (15 mg.) may be given t.i.d. Angina due to anæmia, diabetes mellitus, hyperthyroidism and hypothyroidism, requires treatment of the associated disease together with the administration of sedatives or vasodilators p.r.n.

Jonnesco's operation consisted in the resection of the whole of the cervical sympathetic and first thoracic ganglion. In some cases stellate and upper thoracic ganglionectomy are now performed with relief of pain. It is doubtful whether it is possible to bring a new blood supply to the heart by the formation of adhesions, as in cardio-omentopexy. However, the intercoronary anastomoses may be improved by abrading the parietal and visceral pericardium. This operation has been found helpful in some cases of intractable angina.

Cardiac Infarction

(Coronary Thrombosis. Coronary Occlusion)

Definition. Occlusion of a branch of a coronary artery, with associated cardiac infarction, and not infrequently a localised pericarditis.

Etiology. Cardiac infarction is usually due to thrombosis in an atheromatous coronary artery, rarely to syphilis causing a narrowing of the orifice of the coronary arteries, or to an embolus in bacterial endocarditis.

The view that coronary atherosclerosis is due to excessive fat in the diet, causing an increase in the serum-cholesterol, has been emphasised and supported by observations on the dietary habits and incidence of coronary heart disease in Europeans, Cape Colonials and Bantus in the Cape Peninsula. On the other hand we see many patients with a high blood cholesterol level who do not suffer from coronary thrombosis, and during the war, when the fat intake in this country was low, the incidence of coronary occlusion did not appear to fall. Excessive consumption of sugar, and smoking over 25 cigarettes a day may predispose to coronary disease. Deaths from coronary heart disease in England and Wales are rising. In 1959 approximately 52,000 males and 33,000 females died from this cause.

Pathology. The descending branch of the left coronary artery is most often affected, an infarct forming in the left ventricle. Softening, fibrosis or calcification may develop in the infarct. There is usually a localised fibrinous pericarditis over the infarct, and aneurysm or rupture of the heart may ensue.

Clinical Findings. The patient is usually a male over the age of 50. He may give a history of previous short attacks of anginal pain. In a

8. Intercostal pain from other causes includes a consideration of cervical spondylosis, thoracic spinal arthritis, neuralgia, myalgia, pleurisy, loculated spontaneous left-sided pneumothorax and herpes zoster.

4. Biliary and intestinal colic. These conditions should present no difficulties in differential diagnosis if full investigations are carried out.

5. The scalenus anterior thoracic inlet syndrome (see also p. 455). This is due to pressure of a cervical rib, of a rudimentary first rib or a normal first rib, or of the scalenus anterior muscle on the brachial plexus. The pain is neuralgic in character. It may spread from the neck, down the arm to the hand and is increased by rotation of the head to the affected side, and by a downward pull on the shoulder. Præcordial pain may also be present. Vascular symptoms due to pressure from the rib and clavicle on the subclavian artery include pallor, blueness or gangrene of the fingers; the wrist pulses may be obliterated, and there may be a systolic murmur heard below the clavicle over the artery. Later, the artery may be thrombosed or aneurysmal.

6. Diaphragmatic hernia. The diagnosis is established by a barium examination of the œsophagus and stomach in the erect and Trendelenburg positions.

7. Œsophageal spasm. The pain may disappear on drinking a glass of water. A barium swallow will usually establish the diagnosis.

Course and Complications. In some cases the patient dies during his first attack of angina, in others the attacks recur with gradually increasing severity and progressive myocardial weakness. Complications include acute œdema of the lungs, cerebral hæmorrhage or thrombosis; coronary thrombosis may follow previous attacks of angina.

Prognosis. This is always very uncertain, but sudden death occurs in about 60% of cases, and, of the remainder, a few recover whilst others have repeated attacks at intervals up to 20 years before dying either from angina, from heart failure or intercurrent disease. Unfavourable signs are attacks which are provoked by very slight exertion, attacks which occur during the night, and the presence of pulsus alternans indicating severe myocardial degeneration. Ischæmia of the intestines in visceral angina may lead to mesenteric thrombosis.

Treatment. *During the Attack:* The immediate indication is to relieve pain. A tablet of glyceryl trinitrate (trinitrin) 1/100 gr. (0.6 mg.), should be dissolved under the tongue or a capsule of amyl nitrite 3 to 5 m. (0.2 to 0.3 ml.) should be broken and inhaled through the nose. This almost invariably gives relief if the blood pressure is raised. One or two ounces (30 or 60 ml.) of brandy or whisky frequently relieve the pain, if amyl nitrite is not available. If this fails, a subcutaneous injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) should be given, or an inhalation of chloroform. A subcutaneous injection of atropin. sulph. 1/100 gr. (0.6 mg.) should also be given with a view to overcoming vagal inhibition, which may cause death. If there is much flatulence, the patient should be given 60 m. (4 ml.) of sal volatile (sp. ammon. aromat. B.P.) with an equal quantity of water. The tenderness over the sternum may be relieved by the application of hot flannels.

Between the Attacks: If the angina is a new symptom, or if the attacks are becoming more frequent the patient should go to bed for 2 to 3 weeks

onset usually occurs when the patient is at rest. He becomes restless, the pain is of long duration, and dyspnoea is often present, with sweating. The pulse is feeble, the temperature rises, the blood pressure falls, the cardiac rhythm may become abnormal and pericarditis ensue, there is a leucocytosis, an increased sedimentation rate of the red cells, the electrocardiogram is typical, and the pain is not relieved by nitrites. In angina, on the other hand, the onset is usually related to exercise, the patient stands still, the pain is of brief duration, there is no dyspnoea, and usually little sweating, the pulse is not feeble, the temperature does not rise, the blood pressure rises, the cardiac rhythm is undisturbed, there is no pericarditis or leucocytosis and the sedimentation rate is not increased. The electrocardiographic changes are not so marked, and relief is given by nitrites. A diagnosis of coronary thrombosis must not be excluded on a normal electrocardiogram. An acute abdominal condition may be simulated when the pain is referred to the abdomen and there is vomiting and collapse. Other causes of severe dyspnoea require exclusion in the painless type of coronary thrombosis. A dissecting aneurysm slowly rupturing into the pericardium may exactly simulate an attack of coronary thrombosis, but no typical electrocardiographic findings are obtained.

Course and Complications. The patient may die immediately, or complications, such as ventricular fibrillation, congestive heart failure, pericarditis, cerebral thrombosis or embolus, venous thrombosis in the legs and pulmonary embolus may ensue. Cardiac aneurysm, perforation of the ventricular septum, and rupture of the heart are rare complications. Repeated attacks are not infrequent.

Prognosis. About one third of the cases of coronary thrombosis are immediately fatal. Another third die during the first six weeks of treatment in hospital. The mortality rate of those treated on modern lines has been reduced to about 15%. A second attack occurs in less than half the cases which survive the first attack. A few survive for periods up to twenty years, but the average expectation of life is about eight years.

Treatment. Nitrites must not be given. If the patient is collapsed with a low blood pressure he should lie flat, if there are signs of cardiac failure he should be propped up. An immediate subcutaneous injection of morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (15 to 80 mg.) is required, and this is repeated, if necessary to relieve pain, up to 1 gr. (60 mg.) in 4 hours. Phenobarbitone is given in doses of 1 gr. (60 mg.) twice or three times daily. If there is serious congestive heart failure digitalisation should be effected but it should be remembered that digitalis, strophanthidin and adrenaline may produce ventricular fibrillation. The latter should never be given, and the dosage of digitalis must be carefully watched. Oxygen, administered through a nasal catheter or mask may help to relieve pain, restlessness and dyspnoea. Hyperbaric oxygen at 2 atmospheres absolute pressure for 2 hours may combat shock. A hot water bottle should be placed near the feet. For severe shock, with a blood pressure of 50 mm. Hg. or less, 1-noradrenaline tartrate (Levophed) should be given by intravenous drip. The dose is 4 ml.

typical case he is suddenly seized, while at rest, with severe pain in the middle or lower part of the sternum. The pain may spread to one or both arms, to the neck, jaw or abdomen. In addition there may be severe dyspnoea, nausea and vomiting. The pain is persistent, and lasts for several hours or for a day or so.

On Examination: The patient is usually restless, pale and sweating, and perhaps cyanosed. The heart may show no abnormality at the onset, but the sounds may be distant, or an abnormal rhythm may be present. The pulse: This is often weak, and the rate 90 or 100. The blood pressure characteristically falls, a systolic pressure of 100 mm. Hg. or even 80, being recorded. In some cases there is evidence of venous engorgement, with swelling of the jugular veins, cyanosis, and enlargement of the liver. A few cases have been observed in which there was an absence of pain, the patient being suddenly seized with severe dyspnoea, in others the onset is syncopal with loss of consciousness. The temperature rises shortly after the onset, and may remain raised for 3 or 4 days; this may be demonstrated in some cases by taking the rectal temperature, which is above normal when the mouth temperature may show no rise. A leucocytosis of about 20,000 per c.mm. is generally present with an increase in the sedimentation rate of the red cells. A pericardial rub often develops in a day or so, serving to confirm the diagnosis. Anuria occurs when there is grave shock. The diagnosis can usually be established by the electrocardiographic findings. In a few cases no changes are present at the onset, but typically, soon after the onset, there is a deviation of the R-T segment, usually in opposite directions in leads I and III. Later, the T wave is inverted in leads I or III (T_1 type or T_2 type), and during convalescence the electrocardiogram is gradually restored to normal. The unipolar leads enable a more exact localisation of myocardial infarcts to be made and afford a more definite diagnosis in cases of suspected posterior infarcts (see Fig. 16).

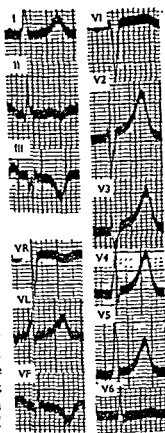


Fig. 16. Electrocardiogram showing unipolar leads in posterior infarction. VF shows elevation of RS-T segment and the sharply inverted T wave. Lead III shows similar changes.

The SGP-T (serum glutamic pyruvic transaminase) and the SGO-T (serum glutamic oxalacetic transaminase) levels are usually raised above the normals of 3 to 35, and 8 to 40 units respectively. The rise occurs within 6 to 12 hours after the infarction and the reading returns to normal within 4 to 7 days.

Differential Diagnosis. Coronary thrombosis is differentiated from angina pectoris on the following grounds. In coronary thrombosis the

stenosis. If the blow is severe immediate death may result from ventricular fibrillation. In other cases there is collapse, followed by præcordial pain, tightness of the chest, dyspnoea and palpitations. The physical signs vary with the lesion produced. Abnormalities are likely to be present in the electrocardiogram. The T waves may be large or inverted and the R-T interval elevated or depressed. Typical coronary T waves may be seen with slurring of the QRS complexes. The patient should be treated as if suffering from coronary occlusion.

THE ENDOCARDIUM

Acute Bacterial Endocarditis

(Malignant or Ulcerative Endocarditis)

Definition. An acute progressive bacterial inflammation of certain parts of the endocardium accompanied by embolic manifestations.

Etiology. There is usually an old valvular lesion. A focus of infection is present in some part of the body from which organisms are carried to the heart. The focus is often latent, and may be in the intestines, tonsils, teeth or elsewhere. Acute bacterial endocarditis may also be associated with pneumonia, osteomyelitis, otitis media, typhoid or scarlet fever and diphtheria. More rarely a primary form occurs, in which no extraneous septic focus can be discovered, and in which there is no evidence of a previous valvular lesion. The organisms multiply in the heart. The organisms are met with in the following order of frequency; the *Streptococcus hæmolyticus*, the *Staphylococcus aureus*, the *E. coli*, the pneumococcus, the gonococcus, the meningococcus. Rarely the infecting organisms are the *Hæmophilus influenza*, the *Streptococcus viridans* the *Staphylococcus albus*, etc. This disease has become comparatively rare since the use of antibiotics.

Pathology. The valves and the endocardium lining the cardiac chambers are chiefly affected. Vegetations form on the surfaces of the valves which are in apposition, such as the atrial aspect of the mitral valve segments and the ventricular surface of the aortic valve cusps. The left side of the heart is usually affected, but in cases of congenital heart disease vegetations form on the right side. They constitute excrescences from the valve or spread along the posterior wall of the left atrium, the wall or septum of the left ventricle (mural endocarditis) or along the aorta. Deep-seated erosions often occur and in this way a valve cusp, the ventricular septum or the heart wall may be perforated, or the chordæ tendinæ ruptured. Septic infarcts are liable to form in the spleen, kidneys, brain, intestines, retina, or, with right-sided lesions, in the lungs.

Clinical Findings. The patient may be attacked by acute bacterial endocarditis during the course of some illness, such as pneumonia, puerperal fever, osteomyelitis, otitis media, a cutaneous wound or a boil, after genito-urinary operations or cardiac surgery, or it may develop apparently spontaneously with or without a previous valvular lesion. The patient is taken ill with malaise and a high swinging temperature, the cause of which is uncertain. The pulse is frequent, and the tempera-

of 1/1,000 noradrenaline in a litre of 4.3% dextrose in 0.18% saline. The amount of fluid injected must not overload the circulation, and the blood pressure should be raised to 100 mm. Hg. It may therefore be necessary to increase the strength of the noradrenaline to 8 or even 64 ml. per litre. Frequent blood pressure readings should be taken. In an emergency a Levophed special ampoule can be used. This does not require dilution and can be given by intravenous or intracardiac injection. A 2 ml. ampoule contains 0.1 mg. noradrenaline in 1 ml. This is 100 micrograms in 1 ml., a 1/10,000 solution. Very little food should be given during the first few days of the illness, and subsequently a diet of about 800 to 1,000 calories is advisable (see p. 243). The fluid intake should be restricted to 80 to 40 fl. oz. (900 to 1,200 ml.). No aperient should be administered for a week, when an enema may be given if required. The use of anticoagulants is said to have reduced the death rate, but this is not proved. Anticoagulants should not be given if there is hepatic or renal disease, severe anaemia, pregnancy, or in the presence of a peptic ulcer or of diverticulitis. Long term anticoagulant treatment involves a risk of hæmorrhage of varying degrees in about 80% of patients. A 4 to 6 weeks course is sufficient. The bleeding may be severe. The patient should be kept in bed for at least a month from the onset of the illness. A low-fat diet is chiefly of value in preventing further attacks in those who are overweight. The vegetable oils, such as corn seed oil, 1 to 2 fl. oz. (30 to 60 ml.) daily, are said to lower the blood cholesterol. As however, they may be found post-mortem deposited in the atheromatous lesions, they may be harmful.

Cardiac Resuscitation

Acute cardiac failure may occur with severe hæmorrhage or trauma, electrocution, anaesthesia, ventricular fibrillation, complete heart-block and coronary infarction.

Resuscitation methods include:—(1) Closed chest massage by lower sternal compressions, 60 a minute, the patient's legs or foot of the bed being raised. (2) Mouth to mouth ventilation, 15 a minute, with the head tilted back and an air-way inserted. (3) Intravenous injection of sodium bicarbonate, 50 m. Eq. (4.2% solution), 150 to 200 m. Eq. followed by 50 m. Eq. every 10 minutes. (4) Intracardiac injection of 1 ml. 1/1,000 adrenaline solution, or of Isopropyl noradrenaline (0.4 mg. in 10 ml.). (5) Defibrillating electrical shock by creating a potential difference across the chest of about 600 volts for 0.1 second.

The results in many cases are disappointing.

Non-penetrating Injuries of the Heart

The heart may be damaged by trauma to the chest wall without the ribs or sternum being fractured. Lesions may occur in the pericardium, myocardium or endocardium. Fibrinous pericarditis, pericardial effusions or adherent pericardium have been noted. The heart may rupture, or an area of scar tissue with subsequent aneurysm of the heart may develop. Injury to the mitral valve has been followed by

(Aureomycin) should be given in addition to the penicillin, in doses of 250 mg. 4 times daily by mouth for a month. Streptomycin or erythromycin must not be given alone, as drug-resistant organisms may appear. Streptomycin combined with sulphadimidine should be given for *H. influenzae* infections. The dosage is given on p. 157.

Subacute Bacterial Endocarditis (*Endocarditis Lenta*)

Definition. A progressive bacterial inflammation of certain parts of the endocardium which tends to run a prolonged course.

Etiology. The disease is caused by infection with the *Streptococcus viridans* in over 90% of cases. This is a streptococcus of the salivary or faecal type. **Predisposing causes:** 1. Chronic rheumatic valvular disease. 2. Congenital heart disease, such as a bicuspid aortic valve, pulmonary stenosis, ventricular septal defects and patent ductus arteriosus. 3. Focal infection, especially in the teeth or tonsils. An attack may follow dental extractions or tonsillectomy carried out without penicillin cover.

Pathology. The aortic or mitral valve is usually affected and there may be no evidence of previous valvular trouble. The vegetations are large and greenish in colour, but ulceration of the valves is not common. The vegetations spread to the walls of the heart chambers. The myocardium is often spared.

Clinical Findings. The patient is usually a young adult male. He notices gradually increasing weakness, with dyspnoea on exertion, loss of weight, sweating and feverishness at night. There may also be pains and vague swellings in the joints. In some cases the initial symptom is pain in the spleen, or pleurisy due to a pulmonary infarct in cases associated with congenital cardiac lesions.

On Examination: The complexion gradually becomes sallow (*café-au-lait* tinge) and the fingers may be clubbed. Small painful red spots (Osler's nodes) may form and subsequently disappear. These are embolic in origin. They are seen on the palmar aspects of the tips of the fingers and toes. Petechial hæmorrhages may occur, especially around the neck and shoulders or under the nails (splinter hæmorrhages). The temperature is usually about 99° to 100° F. (37.2° to 37.8° C.) and runs an irregular course, often being normal for long periods. The pulse is frequent, about 100 to 120. The heart at first often shows no abnormality, later it dilates and a systolic murmur appears at the apex. The appearance of an aortic diastolic murmur is of great significance, indicating endocarditis. The blood: There is a progressive anaemia, with no leucocytosis or a moderate one of about 10,000 per c.mm. The blood culture is usually positive at some period of the disease. The urine: Minute bacterial emboli in the renal glomeruli result in hæmaturia from time to time. Emboli occur in other sites, such as the spleen, the brain, the retinae, the large arteries of the limbs, or the mesentery. The cutaneous lesions mentioned above are probably embolic in nature. An enlarged spleen can often be felt.

ture irregular. The heart is usually dilated and varying cardiac murmurs are heard. There is generally progressive anæmia, and sweats or rigors ensue. Embolic foci or hæmorrhages are indicated by pain in the region of the spleen, by petechial spots or areas of redness in the skin, by splinter hæmorrhages under a nail, by hæmaturia, cerebral symptoms or by diarrhœa. A primary focus may be discovered, such as infection at the root of a tooth, a carbuncle, or osteomyelitis. With the onset of endocarditis the patient becomes more gravely ill. There may be drowsiness and mental apathy, which with diarrhœa, are suggestive of an enterica group infection.

The blood shows a progressive leucocytosis, and with counts over 15,000 per c.mm. the blood culture is usually positive. There is also generally a hypochromic anæmia. The urine: Proteinuria, hæmaturia and the causative organism may be present.

Course and Complications. The course varies with the response to the antibiotics. The embolic manifestations mentioned above can be regarded as complications.

Differential Diagnosis. The diagnosis often presents difficulties, especially when a case is seen for the first time during the illness, and it is not known whether the cardiac murmur is of long standing. Acute bacterial endocarditis requires to be differentiated from such conditions as acute simple endocarditis, subacute bacterial endocarditis, enterica group infections, miliary or acute tuberculosis, septicæmia, malaria, abortus or Malta fever, perinephric abscess, subphrenic or hepatic abscess, meningitis, malignant typhus or small-pox. The cardiac signs are of paramount value in the diagnosis, but splinter hæmorrhages may occur in other conditions.

Prognosis. This has been much improved by adequate treatment with antibiotics.

Treatment. The patient must be kept quietly at rest in bed. Penicillin should be given. The average dose is 500,000 units (600 mg.) of benzylpenicillin every 6 hours. In some cases as much as 8 million units every 24 hours are necessary to control the infection and lower the temperature. If the frequent injections are not well tolerated, 1 to 2 million units of a procaine preparation should be injected every 12 hours. The treatment is usually required for 1 to 2 months. The blood level of penicillin, which is excreted by the renal tubules, may be raised by giving by mouth probenecid (Benemid) 0.5 G. tab., 1 q.i.d., which blocks tubular excretion. Satisfactory results have also been obtained with oral penicillins such as propicillin, 500 mg. 4-hourly, together with probenecid. In patients sensitive to penicillin an antihistamine, such as mepyramine malleate (Anthisan) 50 mg., added to each dose of penicillin, may give protection. A few days later the Anthisan is replaced by oral promethazine hydrochlor. (Phenergan), 25 mg. 6-hourly. If the organism is only moderately sensitive to penicillin, 2 G. streptomycin should also be injected intramuscularly daily. Search should be made for a septic focus, especially in the teeth. If a satisfactory response is not obtained in staphylococcal or streptococcal infections, tetracycline (Achromycin) or chlortetracycline

of acute endocarditis can only be detected by extremely careful and frequent clinical examinations. Thus the pulse rate may gradually rise, the temperature assume a slightly higher plane and changes appear in the cardiac signs. The apex beat may move out slightly, and a localised systolic murmur may be heard there owing to dilatation. As the condition improves the apex beat may return to its normal position and the murmur disappear without there being any indication of permanent cardiac damage. In other cases the systolic murmur may persist, later a diastolic murmur appears, indicating valvular damage. Indications that the heart is definitely affected are the presence of a mid-diastolic, an early diastolic, or a presystolic murmur, localised usually to a small area internal to the apex beat. It is very difficult to hear the early or mid-diastolic murmur unless the heart rate is slow. If the heart recovers, the early and mid-diastolic murmurs may disappear and also the systolic murmur. These early and mid-diastolic murmurs are probably produced by the ventricle sucking the blood through an inflamed mitral valve. An aortic diastolic murmur is less commonly heard. Presystolic triple rhythm, atrial fibrillation or flutter are other indications of carditis. In some cases there may be a dry pericarditis which occurs early in the disease and is associated with pain, restlessness, vomiting and fever. An electrocardiogram may show prolongation of the P-R interval, indicating a degree of heart-block, which is restored to normal as the patient recovers.

Differential Diagnosis. The appearance of a soft diastolic murmur at the apex in the absence of mitral stenosis, or the development of an aortic diastolic murmur is evidence of active carditis.

Course and Complications. The valvular lesion is often progressive. Thus definite signs of mitral stenosis may appear in a few months. Complications include pericarditis or pleurisy, and congestive failure.

Prognosis. There is likely to be permanent valvular damage, either slight and non-progressive, or severe with an increasing valvular defect. Adherent pericardium may still further embarrass the heart's action.

Treatment. The patient must be kept slightly propped up in bed and not allowed to do anything for himself, until the pulse, temperature and respirations are normal. He may then be taken off "absolute" rest, but must lie quietly in bed for another month; then he is gradually raised in bed with more pillows. A careful watch must be kept upon the size of the heart and the heart sounds during convalescence. After 2 to 6 months in bed he is allowed to lie on a couch for graduated periods, if satisfactory progress is being made. The patient should not be allowed up until the sedimentation rate of the red cells is normal. The salicylate treatment is as described for rheumatic fever (see p. 619). Salicylates should be discontinued if a cardiac depressant effect is observed, as shown by weakening of the pulse or dilatation of the heart. Tab. digitalis præp. 1 gr. (60 mg.) or tab. digoxin, 0.25 mg. t.i.d. or larger doses, according to the age of the patient and the response to the drug, should be given if the pulse is rapid or there are signs of congestive failure. If there is a heart-block or a slow rhythm associated with

Differential Diagnosis. It is difficult to make a certain diagnosis in the early stages. Diagnosis is established by the positive blood culture, and by the appearance of cardiac murmurs and of embolic phenomena.

Course and Complications. The course is prolonged unless adequately treated, the illness often lasting for 1 to 2 years. Complications include the embolic processes described above.

Prognosis. This is grave, but has been much improved by the use of antibiotics.

Treatment. Prophylactic. In the presence of congenital heart disease or chronic valvular disease a dental extraction or other operative procedure should be covered with injections of penicillin for 24 hours before and after the operation.

Curative. This is the same as described for acute bacterial endocarditis. Relapses are not infrequent a few weeks after treatment is completed, necessitating a second course of treatment. This usually means a focus of infection remains. The teeth should always be X-rayed during the first course of treatment, and if an apical abscess is present, the offending tooth should be removed. It may also be advisable to remove infected tonsils at the end of the first course of treatment.

Non-Bacterial Endocarditis

Several varieties are described such as the rheumatic, which is the most important, the simple thrombotic which is not associated with rheumatism, the verrucous which occurs in systemic lupus erythematosus, and the calcareous. In verrucous endocarditis no Aschoff bodies are found in the heart muscle, and the vegetations are larger than those found in rheumatic endocarditis and are spread over the mural endocardium.

Acute Rheumatic Carditis

Definition. An acute infective inflammation of certain portions of the endocardium and myocardium, due to the rheumatic state which pursues a relatively benign course.

Etiology. The endocarditis is associated with rheumatic fever and chorea. Less frequently it develops during an attack of tonsillitis or scarlet fever. A recurring endocarditis may appear in cases of long-standing valvular lesions.

Pathology. The lesions probably result from the products of hæmolytic streptococci to which the tissues have become sensitised. Vegetations of varying size form on the valves, especially on the atrial surface of the mitral valve and the ventricular surface of the aortic valve, and more rarely on the mural endocardium of the left atrium or ventricle. Aschoff's nodules may be found in the myocardium. There is always an associated carditis.

Clinical Findings. The patient is usually a young adult between the ages of 10 and 20, who is suffering from rheumatic fever. The onset

about 4 inches (10 cm.) from the mid-line. Palpation : The impulse is forcible, and a systolic thrill is at times felt at the apex. Percussion : The area of cardiac dullness is increased a little downwards and to the left. Auscultation : Both sounds are heard at the apex and base. At the apex there is a systolic murmur accompanying the first sound, and in some cases apparently replacing it, although graphically the first sound is always present. It is maximum in late systole. The murmur may be soft or loud, and is conducted outwards towards the axilla, in some cases being heard as far round as the angle of the scapula or even the spine. The maximum intensity is over the apex. The third heart sound is often heard after the second sound, internal to the apex, especially on inspiration. A clicking "opening snap" is rarely heard, closer to the second sound than is the third heart sound, and more widely distributed over the præcordium. With failure of compensation other signs appear. There is some cyanosis of the face and dyspnoea on slight exertion. The apex of the heart may pass out further to the left, and the rate increase. Irregularity may be noted, due to premature systoles or atrial fibrillation. Further signs of venous engorgement may be found, such as enlargement of the jugular veins in the neck, and dilatation of the tricuspid valve, as indicated by a systolic murmur over the tricuspid valve area. The liver may be enlarged and pulsating, and râles may be heard at the bases of the lungs. Œdema of varying degree may be seen in the ankles and legs, and ascites may be present. The urine is often diminished and contains protein or blood.

Differential Diagnosis. Organic mitral incompetence is not diagnosed so frequently now as it was some years ago. *The conditions under which a systolic murmur may be heard at the apex of the heart are as follows:—*

1. *Physiological.* In an apparently normal individual a soft systolic murmur may be heard at the apex of the heart. This is due to a temporary dilatation of the valve ring, and although it may produce no apparent disturbance of function, it is not a normal condition.

2. *Intracardiac.* The murmur may be : (a) *Hæmic* : Associated with anæmia and dilatation of the valve ring and often heard better at the base than at the apex of the heart. It is soft and often varies with position, rest, exercise and respiration. (b) *Febrile* : This is a soft and localised apical murmur, which may occur during fevers without any evidence of dilatation of the heart, but is probably due to dilatation of the valve ring. (c) *Due to dilatation of the mitral valve ring (relative incompetence)*, as in a dilated and hypertrophied heart. This is a variety of mitral regurgitation. (d) *Organic* : Due to changes in the valve ring or segments as described above. The murmur is blowing and often loud, pansystolic, and conducted towards the axilla. The murmur is little affected by change of position, exercise or by respiration. A mitral systolic thrill usually implies organic disease. There is often enlargement of the left ventricle. Functional ejection murmurs may be caused by a rapid flow of blood through a normal valve into a normal vessel. The murmur usually reaches its height in mid-systole and fades away before the second heart sound. It may occur in pregnancy or thyrotoxicosis.

premature systoles and coupled beats, no digitalis should be given. If there is any septic focus, as in the tonsils, intramuscular injections of penicillin should be given and the tonsils, if infected, should be removed in the later stages of convalescence.

Chronic Valvular Disease of the Heart

Definition. Inflammatory and degenerative changes in the valves of the heart.

Etiology. The following varieties are described: 1. Congenital, especially pulmonary stenosis. 2. Inflammatory. This may be rheumatic, or a sequel of subacute bacterial endocarditis. It may also result from influenza, erysipelas, pneumonia or septicæmia. 3. Syphilitic. The aortic valve and the anterior cusp of the mitral valve are liable to be affected. 4. Arteriosclerotic and calcareous. The aortic valve is involved.

Pathology. Deformity of the valve cusps or ring is likely to occur, but the mural endocardium remains practically unaffected.

Mitral Incompetence

Definition. Reflux of blood from the left ventricle to the left atrium during the ventricular systole.

Etiology. The regurgitation may be due to dilatation or thickening of the valve ring, or to alterations in the valve cusps or chordæ tendinæ preventing effective closure. The valve ring: The orifice may dilate in association with myocardial weakness and dilatation of the left ventricle, in aneurysmal dilatation of the left atrium, in febrile or anæmic states, or in association with enlargement of the left ventricle in aortic disease, or increased blood pressure. It may be thickened from organic changes associated with previous rheumatic or other infections, or with arteriosclerosis. The valve cusps and chordæ tendinæ may be deformed, thickened and adherent as the result of inflammatory changes, and in some cases rupture may occur.

Pathology. In addition to the changes in the ring or valve cusps described above, there is often in valvular cases a certain degree of narrowing of the valve orifice (stenosis) and some enlargement of the left ventricle, and later of the left atrium, and finally of the right side of the heart.

Clinical Findings. The patient often gives a history of previous rheumatic infection. He usually does not complain of any symptoms unless the heart muscle itself begins to fail (failure of compensation). He will then notice a train of symptoms such as undue dyspnoea on exertion, palpitations, and later swelling of the ankles, cough and expectoration.

On Examination: In a well-marked case of fully compensated mitral regurgitation the only abnormal signs will be in the heart. **Inspection:** The apex beat may be displaced a little in the fifth and sixth spaces,

On Examination: The mitral facies may be noted, in which the cheeks and lips have a high colour, with slight cyanosis of the face and ears. The cyanosis is probably due to vascular constriction. The heart. *Inspection:* The apex beat is usually visible in its normal site, but cardiac enlargement occurs with right ventricular hypertrophy. *Palpation:* The impulse is short, forcible or slapping, at the apex. A presystolic apical thrill may be felt. This is a rough vibrating sensation, comparable with that experienced when the hand is placed on the back of a purring cat. It can be timed by simultaneously feeling the carotid impulse. *Percussion:* The right border of the cardiac dulness may be a little "out." *Auscultation:* The characteristic murmur in mitral stenosis is a coarse, low-pitched rumbling sound occurring in diastole. The first sound at the apex is usually accentuated and the second sound rather weak. The pulmonary second sound is accentuated. The duration and intensity of the diastolic murmur depend upon the degree of stenosis and the rapidity and force of the heart beat. In the early stages a short, presystolic murmur is only heard after the patient has exercised, as by sitting up and lying down 20 times, the apex region being then auscultated with the patient lying on the left side. Inhalation with amyl nitrite, 5 m. (0.3 ml.), may also unmask the murmur. The presystolic murmur is usually localised to a point just internal to the apex beat. Later, the murmur is more obvious, extending through diastole. The murmur does not begin immediately after the second sound. The murmur is loud in early diastole, it becomes fainter during mid-diastole, and louder again just before systole. This presystolic crescendo is due to the atrial contraction and is not present when the atria fibrillate. Attention should also be paid to what is known as the mitral "opening snap." Normally the mitral valve opens silently. In mitral stenosis as the valve opens a short clicking sound is heard directly after the second sound, being higher in pitch than the second sound. It is best heard in the third and fourth left spaces, close to the sternum. The diastolic murmur follows the "opening snap."

In early cases no diastolic murmur may be audible, even after exercise, etc. Mitral stenosis may be suspected then by the first sound at the apex being loud and sharp. In mitral regurgitation the first sound is usually weak. The pulmonary second sound may also be accentuated or split.

With fibrillation, signs of failure of compensation are often present. The pulse is usually of low systolic tension, but the diastolic reading may be raised.

Radiographic Findings: A postero-anterior X-ray in a developed case shows prominence or dilatation of the pulmonary artery, conus arteriosus and left atrial appendix. The pulmonary artery becomes prominent owing to hypertrophy of the right ventricle. The aorta is small. The vascular shadows at the hilum are engorged. In the right anterior oblique position, in which the patient is rotated with the right shoulder forwards, through 45°, a shadow in the retrocardiac space due to the dilated left atrium may be seen. Calcification may be apparent

3. *Exocardial*. A cardio-respiratory systolic apical murmur may be due to pleuro-pericardial adhesions, whereby the pressure of air in an adjacent portion of lung is affected by the heart beat. The murmur is usually late systolic and is affected by the phases of respiration. In overacting hearts the ventricular contraction causes the adjacent portion of lung to expand rapidly and suck in air, producing a cardio-respiratory short and blowing murmur. A systolic murmur may be heard in acute pericarditis, but more often there is a "to and fro" murmur.

All diastolic murmurs are organic in origin.

Prognosis. In a simple case, with a healthy myocardium, the heart being normal in size, the exercise tolerance good, and there being no evidence of infection, a full and active life may be expected for many years. If there is aneurysmal dilatation of the left atrium or enlargement of the left ventricle, heart failure is likely to ensue before the age of 50.

Treatment. No treatment is required unless there are indications of failure of compensation. The patient must then be instructed to live well within his reserve of cardiac power and to avoid all strenuous exercise. If decompensation occurs the treatment is as described on p. 243 for the failing heart.

Mitral Stenosis

Definition. *Narrowing of the mitral valve.*

Etiology. Mitral stenosis is usually inflammatory in origin, being a sequel of acute rheumatic endocarditis in about 90% of cases, but it also follows other infections, such as scarlet fever or influenza. Signs of stenosis do not usually show themselves before 2 years after an acute rheumatic attack. Less frequently mitral stenosis is an atheromatous lesion, occurring in people over middle age. Fibro-elastosis may occur in infancy, with thickening of the endocardium due to the formation of fibrous and elastic tissue, especially in the left side of the heart. The mitral and aortic valves may be affected, and mitral stenosis may develop. Sex: Females predominate.

Pathology. The valve ring may be narrow, sclerotic and slit-like (Corrigan's button-hole stenosis), or the cusps may be adherent and the chordæ tendineæ shortened (funnel-shaped stenosis). The former is more common in adults, the latter in children. Secondary changes appear in the heart and elsewhere, such as dilatation and hypertrophy of the left atrium and right ventricle, congestion of the lungs and liver, etc.

Clinical Findings. In a typical case, in which symptoms of failure of compensation are not marked, the patient is often a young adult who gives a history of an infection, particularly that of rheumatic fever, some years before. In many cases, however, no such history can be obtained. The patient may notice no symptoms, or he may complain of palpitations, dyspnoea on exertion, or slight swelling of the ankles towards the evening.

adherent pericardium a presystolic murmur may rarely be heard at the apex, although there is no mitral stenosis: this is due to dilatation of the valve ring and is associated with a systolic apical murmur.

Course and Complications. Mitral stenosis usually pursues a prolonged course, and atrial fibrillation and heart failure do not necessarily ensue. Complications include: Embolism, a clot may be detached from the left atrium and settle in the brain, spleen or kidneys, etc.; or from the right atrium and cause pulmonary embolus with hæmoptysis. Congestion of the lungs, hæmoptysis and bronchitis. Premature systoles, atrial fibrillation and heart failure. Atrial fibrillation, this is often of short duration at the onset, but later it tends to be permanent. Each attack of heart failure is more serious. Laryngeal paralysis, from pressure of the dilated left atrium on the left recurrent laryngeal nerve, and pressure of the atrium on the left bronchus may cause pulmonary collapse. Recurrent attacks of endocarditis may occur.

Prognosis. The presence of mitral stenosis usually means that the patient's life is limited both in activity and in duration. It is a more serious lesion than mitral incompetence and death often occurs before the age of 40. It may cause sudden death, usually from cerebral embolus.

Treatment. The patient must be instructed to live well within his reserve of cardiac power. Failure of compensation and atrial fibrillation are treated as described on pp. 231, 243. Advances in thoracic surgery and information on the pulmonary pressure and cardiac output gained by cardiac catheterisation have enabled some successful cases of mitral valvotomy to be performed. The cases most suitable are those of pure mitral stenosis, with a satisfactory myocardium but progressive lung symptoms and signs. The pulmonary hypertension must not be too far advanced. Embolism is also an indication for operation. Contra-indications are active carditis, associated aortic reflux, considerable mitral incompetence, gross enlargement of the heart or left atrium, and atrial fibrillation or congestive failure of long-standing. Replacement of severely damaged mitral and aortic valves is now possible.

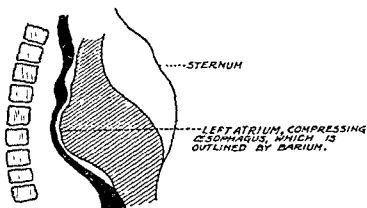
Aortic Incompetence

Definition. Reflux of blood through the aortic valve.

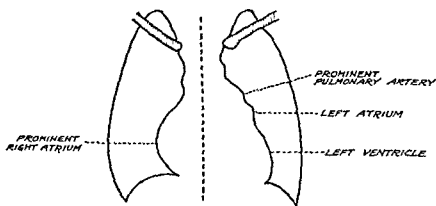
Etiology. Five types are described: 1. Arteriosclerotic. A degenerative lesion, usually associated with syphilis. 2. Endocarditic. This is met with in young people, especially as a complication or sequela of acute rheumatism. 3. Traumatic. A valve cusp may rupture from sudden strain, if it is previously diseased by syphilis or subacute bacterial endocarditis. 4. Congenital. Two valve cusps may be fused, so that they do not close properly. 5. Relative incompetence. Dilatation of the first part of the aorta and of the aortic ring may prevent closure of the cusps.

Pathology. The aortic valve cusps may be puckered and shrunken, with associated stenosis, or show vegetations and destructive lesions due to endocarditis. There is usually hypertrophy of the left ventricle,

in the mitral valve, in the centre of the heart shadow. Pulmonary hæmosiderosis may cause a micro-nodular infiltration of the lungs. With a barium swallow the œsophagus may be seen curving round the dilated left atrium (see Fig. 17). The electrocardiogram is likely to show right axis deviation due to a vertical heart, with big or bifid P waves in



(a) *Right Anterior Oblique or Oblique I* (The patient is turned so that the right shoulder rotates forward through 45 degrees.)



(b) *P-A position.*

FIG. 17. DIAGRAM OF RADIOGRAPHIC APPEARANCES OF THE HEART IN MITRAL STENOSIS.

leads I, II and V_4 , V_5 and V_6 . There may also be evidence of right ventricular hypertrophy and partial right bundle-branch block.

Differential Diagnosis. Accurate timing of apical murmurs is essential. When this is done difficulty usually only occurs in the early stages, when there may be doubt between a short presystolic murmur heard after exercise and an accentuated or reduplicated first sound at the apex. Undoubtedly many cases have been diagnosed as early mitral stenosis, when the subsequent course has shown that no stenosis is present. With aortic incompetence a diastolic murmur (Austin Flint murmur, see p. 264) may be heard at the apex. In

artery a Duroziez murmur may be heard. Duroziez, a Frenchman, in 1861 said that the double intermittent crural murmur, which had previously been described in aortic insufficiency, was a constant sign of this lesion. On listening over the femoral artery, when the stethoscope is lightly applied, a pistol shot sound is heard with each pulsation. On pressing with the finger over the artery, about $\frac{1}{2}$ inch (12.7 mm.) above the stethoscope, a systolic murmur is heard. On pressing with the finger over the artery the same distance below the stethoscope, there is a diastolic murmur. Capillary pulsation (due to vaso-dilatation): On compressing the tip of the nail, so as partially to blanch the nail bed, pulsation may be seen at the junction of the white and red areas; similarly by drawing the finger nail along the forehead and causing a red line to form, capillary pulsation may be seen at the edges of the line. Capillary pulsation may be seen inside the lips, when they are compressed with a glass slide, or in the retinal vessels with the aid of the ophthalmoscope.

Differential Diagnosis. An aortic diastolic murmur may be very difficult to hear in the early stages, absolute silence in the room being essential. The patient should be examined sitting well forward, erect and lying, with the breath held in full inspiration and in full expiration, both before and after exercise, and auscultation should be practised along the right and left borders of the sternum. In a well-developed case the murmur is one of the easiest to detect. There are then usually the concomitant signs of aortic reflux mentioned above.

Course and Complications. Aortic incompetence often pursues a prolonged course, with little effect upon function, so that for instance the patient can play a hard game of tennis. Failure to maintain the cerebral circulation causes giddiness or faintness. Recurrences of endocarditis will result in fever and possibly in embolism. Extension of atheromatous changes may cause angina or aneurysm. Heart failure, with normal or abnormal rhythm, results from myocardial weakness. Aortic stenosis and mitral regurgitation place additional strain upon the myocardium, but a combination of aortic regurgitation and mitral stenosis did not prevent a man from being a successful marathon runner. Hemiplegia may result from cerebral hemorrhage.

Prognosis. In traumatic cases, sudden or rapid death is the rule. With recurrent bacterial endocarditis, death usually occurs in a few months to a year or so. The most favourable outlook is in cases due to a previous endocarditis which is completely arrested. With degenerative lesions coronary disease and myocardial failure usually eventually ensue. When heart failure occurs the prognosis is more unfavourable than is the case with mitral lesions. In any case the possibility of sudden death must be remembered.

Treatment. The Wassermann reaction should be determined, and, if positive, a course of anti-syphilitic treatment given as described on p. 600. Tab. ferriolite 3 gr. (180 mg.) should be given for anaemia, 1 tab. t.d.s. p.c. 6 days a week for several months. For heart failure or atrial fibrillation digitalis should be administered as described on p. 231. Pain is an indication for more complete rest. Surgical reconstruction

the heart being enlarged (*cor bovinum*). There may be fibroid myocardial changes, and atheroma of the aorta and coronary arteries.

Clinical Findings. The patient, who is usually an adult male, may give a history of an attack of rheumatic fever some years ago, or of having contracted syphilis earlier in his life. He may complain of giddiness or faintness at times, or of headache, palpitations and dyspnoea on exertion. In some cases præcordial pain is the first symptom noticed. At times the onset is sudden with fainting or severe dyspnoea.

On Examination : Facial pallor is a characteristic feature, although some authorities consider it is only a sign of bacterial endocarditis. The patient may have an anxious expression, and pulsation of the carotid arteries may be noticeable. The heart. Inspection: The cardiac impulse is forcible and diffuse, and the apex beat is in the sixth or seventh left space, external to the nipple line. Pulsation may be seen in the suprasternal notch. Palpation: The impulse is forcible and usually displaced downwards and outwards. There is generally no thrill. Rarely a diastolic thrill is felt at the aortic base. Percussion: The area of cardiac dullness is increased downwards and to the left. Auscultation: Both sounds are usually heard at the apex. There may be a systolic murmur at the apex due to mitral regurgitation. An Austin Flint murmur may be heard at the apex. This is a rumbling, long diastolic murmur, described by Flint in 1862 as "blubbling," which is thought to be due to the pressure of regurgitant blood in the aorta on the anterior cusp of the mitral valve. At the aortic base, or at times at the pulmonary base, the second sound is replaced by a diastolic murmur, or the second sound may be heard accompanied by a murmur. The diastolic murmur is usually soft and dies away before the end of diastole. When heard at the aortic base it is usually conducted down to the xiphoid process, and more rarely up into the neck. When present over the pulmonary base it may be conducted downwards along the left border of the sternum towards the apex. This is believed by some to indicate a lesion of the left posterior cusp of the aortic valve. The first sound at the aortic area may be normal, or accompanied or replaced by a systolic murmur due to increased blood flow through the aortic valve or to roughening or stenosis of the aortic valve. The rhythm is usually regular, and the rate may be normal or increased. The arteries are often thickened. The pulse: This is typically of the collapsing type, and it is known as the water-hammer or Corrigan's pulse. The water-hammer is a hermetically sealed tube, exhausted of air, and partly filled with water. On inverting it, the water strikes the far end of the tube with a sharp tap. The character of the pulse is best experienced if it is felt with the middle of the fingers rather than with the tips, the patient's arm being first at a low level and then elevated. In the latter position a short sharp tap is felt with systole and the characteristic collapsing sensation with each diastole. The blood pressure: The systolic pressure is high and the diastolic pressure low, such as 170/60 mm. Hg., there being a high pulse pressure. The blood pressure in the legs is higher than that in the arms; this is due to a compensatory mechanism to maintain the cerebral circulation. On auscultation over the femoral

must not be diagnosed solely on the presence of an aortic systolic murmur. This may only indicate roughening of one of the valve cusps, atheroma of the aorta, aneurysm, overaction of the left ventricle, or anæmia. The diagnostic features are the weak aortic second sound, the systolic murmur propagated to the neck, the small anacrotic pulse and left ventricular hypertrophy. If the aortic second sound is absent, there is probably extensive valvular disease.

Course and Complications. The lesion is usually slowly progressive. Complications include bacterial endocarditis, angina pectoris and congestive failure. The latter is of grave significance.

Prognosis. Death usually occurs before the age of 50.

Treatment. The Wassermann reaction should be determined, and, if positive, which is unlikely, a course of anti-syphilitic treatment should be given, as described on p. 600. In all cases strain and over-exertion must be avoided. Valvotomy is less successful than in mitral or pulmonary stenosis, as there is a risk of producing aortic incompetence. A valvular homograft or plastic prosthesis inserted to replace the damaged valve may prove successful.

Tricuspid Incompetence

Definition. Regurgitation of blood from the right ventricle to the right atrium.

Etiology. Tricuspid incompetence is usually associated with dilatation of the right ventricle, and secondary to valvular lesions in the left side of the heart. It may occur with pulmonary fibrosis, chronic bronchitis and emphysema (cor pulmonale). Rheumatic endocarditis causing incompetence rarely affects the tricuspid valve. A congenital variety may also be met with.

Clinical Findings. The onset may be comparatively sudden with acute right-sided heart failure.

On Examination: The face is cyanosed. Venous engorgement may be apparent in the neck, the jugular veins being distended and pulsating with each ventricular systole. The jugulars, when emptied by the finger, will be seen to fill from below. The liver may be enlarged, tender and on bimanual palpation systolic expansion may be felt. The heart. **Palpation:** It is uncommon to feel a systolic thrill over the tricuspid area. **Percussion:** The heart is enlarged to the right. **Auscultation:** There is a soft murmur throughout systole, with its maximum intensity over the fourth right costal cartilage and lower part of the sternum. It may be conducted a little towards the right nipple, or heard at the back near the angle of the right scapula. It is loudest in inspiration. The pulmonary second sound is faint. Other murmurs due to lesions of the mitral or aortic valves may be present. There are usually râles at the bases of the lungs and ascites may be present.

Differential Diagnosis. The systolic murmur must be differentiated from that due to mitral incompetence. The characteristic features of tricuspid regurgitation have been detailed above.

Course and Complications. Relative incompetence may disappear with adequate treatment.

of the aortic valve is a severe and risky operation. A homograft valve or a plastic prosthesis insertion is successful in some cases.

Aortic Stenosis

Definition. Narrowing of the orifice of the aortic valve.

Etiology. Aortic stenosis usually results from inflammatory changes following rheumatic endocarditis, or, in elderly people, it may be caused by calcareous degeneration in the cusps. This has probably developed on an old rheumatic infection. Rarely, if ever, is it due to syphilis. Congenital subaortic stenosis occasionally occurs, or stenosis of the valve itself.

Pathology. The valve cusps are thickened, shrunken and adherent. They lose their mobility and the lumen of the valve orifice is narrowed. Calcareous particles may be found in the cusps. The valve cusps may be judged post-mortem to be incompetent, although no regurgitant murmur was detected during life. The left ventricle is usually hypertrophied, and mitral incompetence is often present. In relative aortic stenosis the orifice is normal in size, but the aorta beyond is dilated.

Clinical Findings. The patient is generally a male over middle age. A history of rheumatic fever, and rarely of syphilis, may be obtained. He may complain of præcordial pain or distress on exertion, of syncopal attacks due to exaggeration of the carotid sinus reflex, or of symptoms due to some complication, such as a retinal venous thrombosis disturbing vision.

On Examination: The patient often appears healthy. The heart. **Inspection:** The cardiac impulse is forcible, and the apex beat is seen in the fifth or sixth left space a little external to the nipple line. **Palpation:** A rough systolic thrill may be felt over the aortic base. The apex beat is forcible. **Percussion:** The area of cardiac dullness is increased, especially downwards and to the left. **Auscultation:** Over the aortic base a rough systolic murmur is heard, conducted upwards into the neck on the right side, and downwards to the apex. The ejection murmur begins as the blood is driven through the narrowed aortic valve opening, it increases in intensity in mid-systole, and fades away before the second sound. The aortic second sound is usually weak, and may be absent. An aortic diastolic murmur may be heard, indicative of aortic reflux (double aortic disease). The pulmonary second sound is often weak, and may be practically inaudible if tricuspid regurgitation is also present, so that it is difficult to hear a second sound at any point over the heart. The aortic systolic murmur may at times be heard at the back, the maximum intensity being just to the left of the fourth thoracic vertebra. The rate of cardiac beat is often slow, such as 50 to 60, and the rhythm regular. **The arteries:** The radial or brachial arteries are often thickened. **The pulse:** This presents the slow, small, but sustained type of impulse, the artery remaining filled between the beats. A tracing shows the anacrotic type, the dicrotic wave being absent or poorly marked. **The blood pressure:** The systolic pressure is not raised, but the diastolic reading may be high, such as 140/100 mm. Hg.

Differential Diagnosis. Aortic stenosis is a rare disease, and

regurgitation from early cases of aortic reflux, in which the pulse is not collapsing and other signs of aortic disease are absent.

Pulmonary Stenosis

Definition. Narrowing of the pulmonary valve.

Etiology. Pulmonary stenosis is usually a congenital lesion, and is described on p. 271. It may be due to compression of the pulmonary artery by a mediastinal tumour or an aortic aneurysm. Rarely it is caused by bacterial endocarditis.

CONGENITAL DISEASE OF THE HEART

Etiology. Congenital heart disease is usually caused by developmental errors, more rarely by foetal endocarditis. The right side of the heart is generally affected, probably owing to the higher pressure which obtains there during foetal life. It is more common in boys, particularly in first-born children. There appears to be a relationship between the occurrence of congenital defects, cardiac, ocular, and deaf-mutism in the child, and an attack of German measles in the mother during pregnancy, especially during the first two months of pregnancy.

Pathology. Congenital lesions may be classified as :—

1. *Abnormalities of Position.* The heart may be situated external to the chest wall, in the neck or in the abdomen (ectopia cordis), or it may be on the right side of the body (dextrocardia) with transposition of the aorta and pulmonary artery. In the latter case the other viscera may be in their normal site or transposed.

2. *Septal and Foetal Passage Defects.* (a) The atrial or ventricular septum may be absent (cor triloculare). (b) The atrial and ventricular septa may be absent (cor biloculare). (c) The atrial septum may be imperfect or a patent foramen ovale may be present. (d) The ventricular septum may be incomplete, usually at the site of the pars membranacea, near the upper end of the septum. (e) The ductus arteriosus may remain patent. Normally this closes by the eighth day after birth, and if it remains patent it does so as a mechanism compensatory to other defects. These include pulmonary stenosis and aortic stenosis, the patent ductus allowing blood to pass to the pulmonary artery from the aorta in the former case, and to the aorta from the pulmonary artery in the latter. A patent ventricular septum is also often present.

3. *Defects of the Main Vessels.* (a) Pulmonary stenosis. This may imply actual atresia of the pulmonary artery, or narrowing of the artery at the valve level or at the infundibulum. (b) Aortic stenosis. The occlusion may occur at the valve ring, between this and the entrance of the ductus arteriosus, or at the point just below the entrance of the ductus arteriosus (coarctation of the aorta, see p. 273).

4. *Valvular Defects.* (a) The pulmonary valve. Pulmonary stenosis may be due to shrinkage of the valve cusps, or to narrowing of the valve ring, or a supernumerary cusp may be present often associated with a patent foramen ovale or persistent ductus arteriosus. Only two cusps may be present, or there may be a supernumerary one. Pulmonary regurgitation is uncommon. (b) The tricuspid valve. Congenital

Prognosis. This is serious, as the lesion is indicative of a severe degree of heart failure.

Treatment. Venesection and digitalisation are usually required.

Tricuspid Stenosis

Definition. Narrowing of the orifice of the tricuspid valve.

Etiology. Tricuspid stenosis is a very rare lesion, either resulting from previous rheumatic endocarditis or being congenital in origin.

Pathology. The narrowed tricuspid orifice is often associated with mitral stenosis.

Clinical Findings. The patient may be cyanosed and the skin of the face and neck pigmented. Despite evidence of right heart failure the patient may show little distress. The heart. Palpation: A presystolic thrill may be felt over the right side of the lower part of the sternum. Percussion: The heart is enlarged to the right. Auscultation: A diastolic murmur, usually mid-diastolic, is heard with maximum intensity over the lower part of the sternum, conducted slightly upwards and to the right. It is loudest in inspiration. X-ray examination shows considerable enlargement of the right atrium. The electrocardiogram shows tall, sharp P waves, in lead II, which are often wide if mitral stenosis is also present. The liver: It may be possible to detect presystolic (atrial systolic) pulsation. The liver is usually enlarged, firm and not tender (cardiac cirrhosis). There is frequently œdema of the ankles and ascites develops later.

Differential Diagnosis. As tricuspid stenosis is so rare, it must be very carefully differentiated from mitral stenosis, with which it is usually associated. With the onset of atrial fibrillation the diastolic murmur usually disappears.

Treatment. This is as for atrial fibrillation or for right-sided cardiac failure (see 231, 239). Valvotomy has been occasionally successful.

Pulmonary Regurgitation

Definition. Regurgitation of blood through the pulmonary valve.

Etiology. Pulmonary regurgitation may occur as a complication of mitral stenosis, due to increased pressure in the pulmonary circuit with dilatation of the pulmonary artery. It may also be due to bacterial endocarditis grafted on a congenital pulmonary stenosis, or more rarely it occurs as a congenital lesion combined with pulmonary stenosis. It is a very rare valvular lesion.

Clinical Findings. The characteristic sign is a diminuendo soft diastolic murmur, following the second sound, with maximum intensity in the second and third left spaces, near to the sternum. It is conducted down the left border of the sternum. The pulmonary diastolic murmur, which may be heard in advanced cases of mitral stenosis, is known as a Graham Steell murmur, and is thought to be due to pulmonary regurgitation. It is known as the murmur of pulmonary hypertension, and when first developed is not usually constant.

Differential Diagnosis. It is very difficult to diagnose pulmonary

cæruleus), and a murmur is audible over the præcordium. Later in life, if the child is examined by the doctor for the first time, a history may be obtained that he has been blue from birth, and the parents may have been told that the heart was affected. There is generally no history of rheumatism which might account for the heart murmur.

On Examination : The child is often stunted in growth, and he may be mentally backward. When cyanosed he tends to adopt a squatting position. The fingers and toes are generally clubbed. The blood shows an excess of red cells and of hæmoglobin, the red cells numbering from 7 to 12 millions per c.mm., and the hæmoglobin may be as high as 150% (22.1 G. Hb./100 ml.). It is often difficult or impossible to diagnose the exact nature of the lesion, and more than one defect may be present. The typical findings in the more important congenital lesions will now be described.

Pulmonary Stenosis

There are two types : 1. Subvalvular or infundibular. This is usually associated with other cardiac defects such as Fallot's tetralogy. 2. Valvular. In about 90% of cases the stenosis is valvular. Cases may be acyanotic when uncomplicated by septal defects, unless peripheral vaso-constriction leads to a peripheral cyanosis. When there is a right to left shunt through a functioning patent foramen ovale cyanosis occurs, often with clubbing of the fingers and polycythæmia. There may be severe dyspnœa or angina of effort on hurrying. The physical signs which may be found in valvular stenosis are as follows : The heart. Palpation : A systolic thrill may be felt in the second or third left spaces near the sternum. Percussion : The dulness is increased to the right. Auscultation : A harsh systolic ejection murmur is heard *over the pulmonary base sometimes preceded by a click; the pulmonary second sound is weak or absent.* The right ventricle is enlarged and may produce a bulging or heaving of the sternum and there may be venous engorgement in the neck. The electrocardiogram shows right ventricular hypertrophy. Radiography and cardiac catheterisation enable a more accurate diagnosis to be made of the nature of the lesion or lesions present. Pulmonary valvotomy should be considered in cases with cyanosis and valvular stenosis.

Patent Ductus Arteriosus

Frequently there are no symptoms, the patient is not cyanosed and the fingers are not clubbed. The heart. Pulsation may be seen in the second and third left spaces, near the sternum, due to enlargement of the pulmonary artery. A systolic thrill may be felt at the site of the pulsation, and a diastolic shock may be present. Auscultation : A murmur may be heard, which is harsh or blowing, and begins just after the onset of the first sound. It fades away towards mid-diastole, and becomes loud again with each systole (*water wheel or machinery murmur*). The murmur is maximal at the second or third left space

regurgitation or stenosis may occur. (c) The aortic valve. Two cusps only may be present, and the valve be incompetent, or there may be a supernumerary cusp. (d) The mitral valve. This is rarely stenosed.

5. *Defects of Conducting Tissue.* Congenital heart-block is usually due to a deficiency of the upper part of the ventricular septum, the atrio-ventricular bundle ending in a band of fibrous tissue.

6. *Combined Lesions*, such as *Fallot's tetralogy*. In this there is stenosis or hypoplasia of the pulmonary artery, a defect in the ventricular septum, the aorta communicates with both ventricles, and the right ventricle is hypertrophied. The *Eisenmenger complex* differs from *Fallot's tetralogy* inasmuch as the right ventricular conus and pulmonary valve are normal, and the pulmonary artery is dilated.

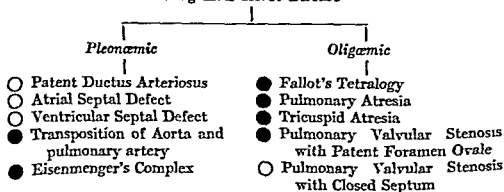
In the *Lutembacher complex* there is an atrial septal defect combined with mitral stenosis. It is generally believed that the latter lesion is acquired and not congenital in origin.

Clinical Findings. Cases of congenital heart disease may be classified as cyanotic and acyanotic. The cyanotic are blue when at rest, owing to a venous-arterial, right to left shunt. Some cases show a border-line cyanosis which may slowly increase owing to changes in intracardiac pressure or to heart failure. The cyanotic group includes *Fallot's tetralogy*, the *Eisenmenger complex*, pulmonary valvular stenosis with patent foramen ovale, pulmonary atresia, tricuspid atresia and transposition of the aorta and pulmonary artery. The acyanotic group embraces patent ductus arteriosus, atrial septal defect, ventricular septal defect, pulmonary valvular defect with closed septum, and coarctation of the aorta.

Campbell also classifies cases of congenital heart disease into *oligæmic*, with diminished blood flow to the lungs and hypertranslucent lung fields as seen on X-ray examination, and *pleonæmic*, with increased blood flow to the lungs and dense lung fields as seen radiographically. Here, there is a left to right shunt. The table below shows Campbell's classification.

In a typical case, in which there is deficient aeration, the condition is noted at or shortly after birth. The baby is cyanosed and blue (*morbus*

Congenital Heart Disease



● = Cyanotic ○ = Acyanotic

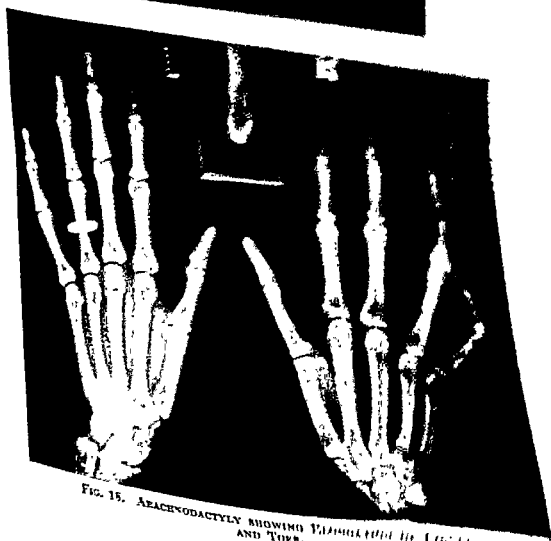


FIG. 15. ARACHNODACTYLY SHOWING ELONGATION OF METACARPALS AND TUBS.

near the sternum, and it may be conducted towards the left clavicle, or heard at the back in the left interscapular region. It is due to blood flowing from the aorta to the pulmonary artery. The pulmonary second sound is accentuated. At the apex the second sound may be reduplicated. The pulse may show an increased pulse pressure. X-ray examination often shows dilatation and pulsation of the pulmonary artery and pulsating hilar vessels. The electrocardiogram is usually normal. Angiocardiography may show the pulmonary artery filling from the right ventricle first and then from the aorta. Cardiac catheterisation usually shows blood from the right atrium and ventricle with a normal oxygen content (70% saturated), whereas blood from the pulmonary artery is over 80% saturated. Death usually occurs before the age of 40, either from bacterial endocarditis or congestive failure. Paradoxical embolus may occur, a clot passing from the left atrium or from the mitral or aortic valve to the lung. Surgical treatment consists in ligation or excision of the ductus under penicillin cover. This should prevent bacterial endocarditis developing. If it is present it should be eradicated by penicillin before operation.

Patent Ventricular Septum

The heart. Auscultation: A loud or harsh murmur (*bruit de Roger*) may be heard, which starts early in systole and extends into diastole. It may be audible in the mid-sternal line, or along the left sternal border near the third costal cartilage, or lower down near the xiphoid process. It is not conducted to the neck or to the axilla. The pulmonary second sound is audible. Many cases are symptomless in early life. The lesion may be associated with congenital heart block or with Fallot's tetralogy. Bacterial endocarditis may develop, usually on the right side.

Patent Foramen Ovale

With a large atrial septal defect (A.S.D.) the blood passes from the left atrium to the right atrium. There is enlargement of the right side of the heart and of the pulmonary artery. The hilar branches of the pulmonary artery may reach aneurysmal size. A mid-systolic murmur is heard over the middle or upper part of the sternum on the left side, and the pulmonary second sound is usually accentuated and split, or pulmonary incompetence may occur. Right bundle-branch block is found in about 95% of cases. Cardiac catheterisation will determine whether a shunt is taking place between the atria, as in about 25% of normal people the foramen is patent, although functionless. Patent foramen ovale may be associated with mitral stenosis (the Lutembacher complex) or with arachnodactyly (Marfan's syndrome). In the latter the fingers and toes are elongated (see Fig. 18), the face is thin, the skeletal muscles are poorly developed, the palate has a high arch, the chest is pigeon shaped and the lenses are dislocated. Congenital lesions

of the urinary tract rarely occur. The atrial septal defect often causes no symptoms until middle life, when heart failure or more rarely bacterial endocarditis may supervene. In countries in which schistosomiasis is endemic the radiological appearances of the heart in bilharzial heart disease may be indistinguishable from those of atrial septal defect. The septal defect can be repaired surgically.

Coarctation of the Aorta

Two types are described : 1. Adult. The constriction is at the site of the ductus arteriosus. 2. Infantile. There is narrowing of the isthmus between the left subclavian artery and the ductus arteriosus. The patient usually complains of no symptoms, but intermittent claudication may occur.

Signs of hypertensive heart disease are usually present. The characteristic features of coarctation are : The blood pressure is raised in the arms, and low in the legs. Animal experiments indicate that the hypertension in the arms is of renal origin. The systolic brachial pressure may be 150 to 160 mm. Hg. in a child of 10 years, and often no pulsation can be felt in the femoral arteries. Enlarged and tortuous arteries may be seen or felt in the chest, especially in the interscapular region or in the neck and arms. X-ray examination may reveal notching of the ribs due to the enlarged intercostal arteries (Roesler's sign). The ascending aorta dilates and the aortic knob is small. Angiocardiography will reveal the aortic constriction. Death may result from congestive failure, rupture of the heart or aorta, cerebral hæmorrhage or bacterial endocarditis. Death usually occurs before the age of 40. Surgical repair has proved successful in many cases, the operation mortality rate being about 8% or lower.

Fallot's Tetralogy

This is a cause of cyanosis, polycythæmia and clubbing of the fingers and toes. The lesions are described on page 270. A systolic thrill and murmur are usually present near the sternum in the second and third left spaces. The X-ray findings are typical, the heart having a *cœur en sabot* appearance, the aorta is displaced to the right, the right ventricle is hypertrophied, and there is a concavity where the shadow of the pulmonary artery should be seen. Angiocardiography which shows simultaneous filling of the aorta and pulmonary artery, and cardiac catheterisation which confirms the presence of pulmonary stenosis, are helpful in the diagnosis of doubtful cases. Surgical repair consists in closure of the septal defect and resection of the stenosis.

aorta there are usually found the scars of syphilitic aortitis. In cystic necrosis of the aorta there is degeneration of muscular and elastic tissue in the media, with the formation of small cystic areas containing mucoid material. About 75% of aortic aneurysms are thoracic involving the arch, and about 10% are abdominal. The clinical findings of aortic aneurysms will be considered under separate headings, according to the portion of the aorta involved.

Aneurysm of the Thoracic Aorta

An aneurysm of the ascending part of the arch is one of physical signs, whereas aneurysms of the transverse and descending parts of the aortic arch give rise chiefly to symptoms, due to pressure effects.

Aneurysm of the Aortic Sinuses

Clinical Findings. The patient may be a comparatively young man, between 30 and 40 years of age. He may complain of faintness, præcordial distress, headache or of pain resembling that of angina.

On Examination: Generally no signs of aneurysm are detected, but there is evidence of aortic reflux. In some instances, owing to pressure of the aneurysm on the inferior vena cava, there is œdema of the legs, ascites, and enlargement of veins in the abdominal wall. Sudden death may occur from rupture into the pericardium. In other cases the rupture may be more gradual and of a dissecting character.

Fusiform Dilatation of the Aortic Arch

Clinical Findings. The patient is usually an adult male past middle age. He may have no symptoms, or he may notice a little difficulty in breathing or in swallowing. In other cases the symptoms are characteristic of aortic reflux.

On Examination: **Inspection:** The patient must be viewed in a good light, both from the side and in front. Pulsation may be seen just above the manubrium sterni, or in the first or second right intercostal space close to the sternum, or the manubrium sterni itself may pulsate. **Palpation:** The impulse may be felt at these sites. The cardiac apex is usually forcible, and it is often displaced a little downwards and outwards. A systolic thrill may be present over the aortic base, with a diastolic shock. **Percussion:** An area of dulness may be detected over the manubrium sterni. **Auscultation:** The aortic second sound may be clear and ringing, or an aortic diastolic murmur may be heard. There may also be an aortic systolic murmur. **The arteries:** These are usually thickened. Absence of the brachial and radial pulses on both sides has been recorded, probably owing to obstruction of the orifices of the innominate and left common carotid and subclavian arteries. **The blood:** The Wassermann reaction is not necessarily positive. **X-ray examination:** Screening in the postero-anterior and oblique positions will reveal the dilatation of the aorta. It should be remembered that pulsation can often be felt in the jugular (supraster-

rudimentary. The electrocardiogram shows left axis deviation. The blood supply of the lungs is reduced, and is maintained through a patent ventricular septum, patent ductus or a bronchial collateral circulation.

ANEURYSM

Definition. An abnormal dilatation of an artery, resulting from changes in its walls.

Varieties. Aneurysms may be subdivided into : 1. True aneurysms. The wall contains one or more of the arterial coats. They may be : (a) Fusiform or dilatation. The aortic arch is especially liable to be thus affected. (b) Saccular. A localised swelling may form on large or small arteries. (c) Dissecting. A new channel is formed in the media through which the blood flows for a variable distance before regaining its normal path. (d) Cirroid. A small artery and its branches are involved in a fusiform dilatation.

2. Arterio-venous aneurysms. These may be : (a) An aneurysmal varix. There is direct communication between an artery and a vein. (b) A varicose aneurysm. The artery and vein communicate through a sac.

3. False aneurysms. A swelling containing blood communicates with an artery, but the walls of the swelling are not formed by the arterial coats.

The fusiform, sacculated and dissecting aneurysms are of medical importance, the other varieties are chiefly of surgical interest. Small saccular aneurysms ("berry" aneurysms) may occur in the cerebral or retinal arteries, or elsewhere in the body. They are of clinical importance when occurring in the brain (see p. 318).

Aortic Aneurysm

Etiology. Syphilis is the most important cause and owing to the more efficient early treatment of syphilis, aneurysms are much more rare than they were formerly. The fusiform type, however, may be associated with arteriosclerosis and not with syphilis. A fusiform aneurysm may also develop in association with coarctation of the aorta. Cystic necrosis of the aorta is also a cause of dissecting aneurysm, which may subsequently rupture. Mycotic aneurysms occur in association with bacterial endocarditis and septicæmia, emboli being carried to the vasa vasorum of the arterial wall. Such mycotic aneurysms are usually multiple. *Predisposing causes* : 1. Age : Usually over 50. 2. Sex : Males especially. 3. Occupation : Involving strain.

Pathology. Syphilis causes a mesoarteritis, the elastic and muscular fibres degenerate and the wall of the aorta yields to the pressure of its contents. The sac of the aneurysm is formed internally of layers of blood clot, outside which are the remains of the middle coat, the outer coat, fibrous tissue and perhaps surrounding structures to which it becomes adherent, such as the sternum, vertebrae or trachea. Calcareous plaques may be seen on its inner surface. In the adjacent parts of the

scapulæ, round the chest or down the arms. There may be swelling of the face, the neck or the left arm. The dyspnœa may be relieved if the patient stoops forward, as this tends to increase the antero-posterior diameter of the chest.

On Examination: Inspection: Pulsation may be seen over the manubrium sterni or in the left interscapular region. Palpation: Pulsation or a thrill may be felt over the manubrium. Percussion: The heart may be enlarged downwards and to the left; dulness may be present over the manubrium. Auscultation: The aortic second sound may be accentuated. *Further signs of aneurysm:* A tracheal tug may be felt, if the cricoid cartilage is elevated with the forefingers, while the patient lifts up his head. The larynx may not move upwards with deglutition. The air entry may be weak over the upper or lower lobe of the left lung, and signs of bronchitis or of bronchiectasis may be found in the left lung. More rarely signs of distention of the left lung are noted, the note being hyperresonant and the breath sounds weak. Pressure on the left recurrent laryngeal nerve may cause laryngeal paralysis. The left pupil may be dilated from stimulation, or constricted from paralysis of the sympathetic. There may be flushing or sweating limited to one side of the face, corresponding with the side of the aneurysm. Slowing of the heart may result from stimulation of the vagus. Pressure on the phrenic nerve may cause hiccough or paralysis of the left half of the diaphragm. Pain in the chest or left arm may be due to pressure on the intercostal nerves or the brachial plexus. The left pulse may be weaker than the right if the aneurysm is situated between the innominate and the left subclavian arteries, and the blood pressure lower in the left arm than in the right. Lowering of blood pressure in the left carotid artery may also cause dilatation of the left pupil, due to relaxation of the vessels in the left iris. Pressure on the thoracic duct may result in chylothorax, and œsophageal pressure may cause dysphagia.

Aneurysm of the Descending Thoracic Aorta

Clinical Findings. The patient may complain of a gnawing pain in the back in the thoracic region, radiating around the chest or spreading to the lumbar area. There may be pains in the legs, or weakness, or later, paralysis. Dysphagia, cough and expectoration are also sometimes present.

On Examination: Inspection: The back should be examined in a good light, with the patient sitting up. It should be viewed from side to side, when a pulsating area may be seen usually low down to the left of the thoracic vertebræ. Palpation: Pulsation or a thrill may be felt in the left interscapular region or just below this area. Percussion: The note may be impaired over this area. Auscultation: A systolic murmur may be heard in the left interscapular region. The arteries: The radial pulses are equal, but the femoral pulses may be weak or absent. The lungs: There may be signs of bronchitis or of bronchiectasis in the left lung, or of a left pleural effusion. In more advanced cases erosion of the bodies of the vertebræ results in kyphosis or

nal) notch, without any dilatation of the aorta being present, usually when the aorta is uncoiled. In the doubtful cases of aortic aneurysm angiography is likely to be of value.

Saccular Aneurysm of the Ascending Arch

Clinical Findings. The patient is usually an adult male, past middle age. He may give a history of syphilis years ago. The symptoms are very variable. Thus there may be no complaint of ill health, or the patient may notice pain in the region of the sternum on the right side of the chest, or in the back between the shoulders. He may complain of swelling of the face, neck, arms or hands, or of a feeling of engorgement of the face and neck, particularly on stooping. There may be dyspnoea on exertion or paroxysms of coughing. Slight stridor may have been noted when the patient is asleep. In some cases a throbbing is felt in the aneurysm, or hæmoptysis may be the first symptom.

On Examination : **Inspection :** The face and neck may be high-coloured, with injected conjunctivæ, and one or both arms may be swollen. Enlarged veins may be seen on the front of the chest. When the patient stoops down there is often considerable congestion of the face and neck. In rare cases, when there is interference with the blood supply to one arm, as in aneurysm of the innominate artery, unilateral clubbing of the fingers may be present. Slight pulsation may be detected in the second or third right space near the sternum, or there may be a definite pulsating swelling the size of a golf ball or larger. **Palpation :** Pulsation may be felt in the sites mentioned above, and, with an aneurysm, the pulsation may be expansile. A systolic thrill is rarely felt. The apex beat is usually forcible, and displaced a little downwards and outwards. **Percussion :** Dulness may extend outwards from the manubrium sterni to the right, in the first to third spaces, for 1 or 2 inches. **Auscultation :** The aortic second sound is accentuated, and a systolic murmur may be heard over the pulsating area. The pulse : The radial pulses may be unequal in force or in time, but this only occurs in about 4% of aortic aneurysms. A difference of blood pressure of over 20 mm. Hg. in the two arms is also of diagnostic significance. The lungs : Pressure on the right eparterial bronchus may result in slight dulness and weak air entry over the apex of the right lung. The trachea : Pressure here may cause dyspnoea, stridor (the leopard growl) or a harsh cough (gander cough). The right recurrent laryngeal nerve : This is rarely involved ; pressure produces first abductor paralysis and later a complete paralysis. In the latter stage the cough is described as "bovine," lacking any explosive character. The blood : The Wassermann reaction is positive in a high percentage of cases. Death has been recorded from rupture into the pulmonary artery.

Saccular Aneurysm of the Transverse and Descending Arch

Clinical Findings The patient is likely to complain of pressure symptoms. He may notice shortness of breath, either on slight exertion or when at rest, cough, expectoration, or difficulty in swallowing solid food. There may be pain under the sternum, in the back between the

intima ruptures and blood tears up a path between the coats of the aorta. Rupture of the dissecting aneurysm is usually a terminal event.

Clinical Findings. This is not an uncommon condition. The patient is usually a male, and often apparently in good health. In other cases he is known to be suffering from hypertension. In women about 50% of cases are associated with pregnancy. The patient may be suddenly seized with agonising pain, either in the chest, between the scapulae, at the back of the neck, in the loins or in the abdomen. The pain may radiate to the head, arms, pelvis or legs. In other cases there is no pain, the onset being sudden with loss of consciousness, and neurological signs may be found in the limbs. The pulse is often slow and feeble according to the degree of shock and collapse. In some cases hypertension persists, in others there is extreme dyspnoea. Swelling of the neck may be noted when the rupture occurs in the region of the aortic arch. Extensive bruising, appearing in a few hours in the skin of the neck, chest or abdomen is very suggestive. The electrocardiogram shows no evidence of coronary infarction.

Course and Complications. If rupture has not occurred the patient may recover from the initial attack, only to have further attacks, one of which proves fatal. In some cases, however, the patient dies from another disease, and the dissection is discovered at autopsy.

Differential Diagnosis. Such conditions as coronary occlusion, an acute abdominal emergency, a cerebral hæmorrhage, or acute lumbago may be diagnosed. In one of my cases the pain came on suddenly in the left lumbar region, as the patient stretched up in bed to switch on the light. Few cases are diagnosed during life.

Treatment. Morphine sulph. $\frac{1}{4}$ gr. (15 mg.) or Omnopon $\frac{1}{4}$ gr. (20 mg.) should be injected, and repeated as necessary to dull the pain. Replacement of the aneurysm by a plastic tube may be possible.

Arteriosclerosis

Definition. Local or diffuse hardening of arteries due to inflammatory or degenerative changes in their coats.

Varieties. From the clinical standpoint arteriosclerosis may be divided into two main classes, atherosclerosis which affects the aorta and its main branches, and peripheral arteriosclerosis.

Atherosclerosis

Etiology. Atherosclerosis is considered to be due to a defect in cholesterol metabolism. *Predisposing causes:* 1. Age. The incidence increases with age. 2. Sex. Males predominate, but after the menopause the incidence is about equal. 3. High blood pressure. 4. Hypercholesterolaemia. 5. A hereditary diathesis. 6. Overeating and overdrinking. 7. Obesity. 8. Excessive consumption of sugar.

Pathology. The early lesion consists of yellow streaks in the aorta composed of cholesterol, phospholipids and protein. It is situated in the intima. Later, the atheromatous plaque forms. The aorta and large arteries are chiefly affected, also the coronary and cerebral vessels, and those supplying the lower limbs rather than the arteries of the arms.

compression paraplegia, with sensory and motor disturbances in the legs.

Prognosis. A thoracic aneurysm is a very serious disease, and recovery is not to be expected. Death usually occurs between 4 and 15 years from the time of diagnosis.

Treatment. *Prophylactic.* Syphilis should be treated adequately and early.

Curative. The anti-syphilitic treatment described on p. 600 should be given, but it is advisable to keep the patient in bed for at least 3 months after the diagnosis is made. This will aid clotting by diminishing the circulation rate. If there is venous engorgement, venesection of 10 to 20 fl. oz. (300 to 600 ml.) from the arm often affords much relief, and can be repeated as required. The diet should be moderate. A regular daily action of the bowels should be secured. The pain is generally relieved by the iodides, but if very severe, *Nepenthe* 10 to 15 m. (0.6 to 1 ml.) may be required or tab. pethidin. hydrochlor. 50 mg. by mouth. When the patient is allowed up, all violent exercise or strain must be avoided. Surgical treatment consists in replacement of the whole aortic arch with a plastic tube, "with substitution of the innominate, left carotid and left subclavian arteries."

Aneurysm of the Abdominal Aorta

Saccular, fusiform or dissecting aneurysms may develop. A saccular aneurysm near the origin of the coeliac axis artery is perhaps the most common variety.

Clinical Findings. The patient complains of abdominal or lumbar pain. It is a continuous type of pain, and may be intensified by lying down.

On Examination: *Inspection:* With a large aneurysm a pulsating swelling may be seen in the epigastrium, or at times in the back near the lumbar vertebræ. *Palpation:* A pulsating swelling is felt in the abdomen. This is definitely expansile. The femoral pulses may be obliterated. In some cases an aneurysm may form on a renal artery, with the appearance of a large pulsating swelling in the loin.

Differential Diagnosis. A pulsating abdominal aorta is frequently noted in thin patients, especially in women. It does not usually cause pain, although its throbbing may produce discomfort. The swelling is not expansile, the femoral pulses are normal and there are no pressure symptoms, such as may result with an abdominal aneurysm from erosion of the vertebræ. An abdominal tumour may receive transmitted pulsation from the aorta. If the patient is examined in the knee-elbow position, the pulsation usually disappears as the tumour drops forward.

Treatment. This is as for thoracic aneurysm. It may be possible to resect the aneurysm and replace it with a plastic tube.

Dissecting Aneurysm

Pathology. A dissecting aneurysm may form in any part of the aorta. It is usually secondary to cystic necrosis of the media. The

brachial, facial, temporal, femoral and dorsalis pedis. The radial artery may be firm like a whipcord in diffuse hyperplastic sclerosis, or calcified nodules may be felt in atheroma, or it may be hard like a pipe-stem, in the medial type. The radial and brachial arteries are sometimes tortuous, and this may occur without calcification. Tortuosity of the temporal arteries does not necessarily imply arteriosclerosis. Ophthalmoscopic examination may show arteriosclerotic changes in the retinal vessels.

Cerebral Symptoms. There may be mental deterioration, lack of concentration and insomnia; or attacks of giddiness, temporary loss of consciousness, paresis, aphasia or epileptiform convulsions may occur. Arteriosclerotic Parkinsonism is also described, characterised by rigidity, affecting especially the trunk and lower limbs, a mask-like expression, and bradykinesia. Transitory blindness due to spasm of the vessels may ensue. Cerebral thrombosis or hæmorrhage are more serious complications.

Cardiac Symptoms. Atherosclerosis of the aorta or coronary arteries may lead to aneurysm of the aorta, aortic incompetence, myocardial degeneration, cardiac hypertrophy, angina pectoris, coronary thrombosis, or aneurysm of the heart followed by rupture.

Abdominal Symptoms. Attacks of abdominal pain, constipation or mesenteric thrombosis may ensue.

Renal and Vesical Symptoms. Arteriosclerotic kidneys may result in chronic nephritis, usually without œdema. Hæmaturia may result from arteriosclerosis of vessels in the bladder.

Peripheral Symptoms. Involvement of the arterial supply of the extremities, especially the legs, results in intermittent claudication. The patient finds he cannot walk more than a few yards without severe pain in the legs, which ceases as soon as he rests. In some cases it is possible to walk it off. In more advanced cases there may be pain and cramps apart from exercise, and gangrene may slowly set in. In the diffuse hyperplastic sclerosis the clinical picture is that of a systolic blood pressure of 180 mm. Hg. or more, with secondary cardiac hypertrophy (hypertensive heart disease). This is known clinically as hyperpiesia or essential hypertension.

Differential Diagnosis. Arteriosclerosis is usually easily diagnosed by palpating the peripheral vessels. In the medial form, an X-ray film may show the calcification. It may be associated with cystic degeneration of the popliteal artery. Intermittent claudication due to arteriosclerosis must be differentiated from thrombo-angiitis obliterans. The characteristic features of the latter disease are that it occurs in younger men, usually Hebrews, and migrating phlebitis is also present in the legs.

Course and Complications. The arterial changes are progressive, and complications such as hæmorrhage, gangrene or muscular degeneration are liable to occur from interference with the blood supply to the tissues. Bronchitis may develop.

Prognosis. The outlook is more unfavourable when calcification occurs in the arteries of a young man. Myocardial degeneration, aneurysm and renal inefficiency all increase the severity of the condition.

Fatty degeneration may lead to an atheromatous ulcer, and calcification may ensue.

Peripheral Arteriosclerosis

There are two main types, medial sclerosis or Mönckeberg's sclerosis, and the diffuse hyperplastic sclerosis of Gull and Sutton.

Medial Sclerosis

Pathology. Fatty degeneration and calcification occur in the media, with the formation of pipe-stem vessels. The intima is secondarily thickened. It commonly affects the arteries in old age and in association with diabetes mellitus. Mönckeberg said that the brachial arteries are seldom involved. Despite this the common variety of arteriosclerosis, characterised by thickening and tortuosity of the brachial arteries, does not appear to fall into any of these categories, but it is usually held to be a variety of medial sclerosis. The blood pressure is not necessarily raised.

Diffuse Hyperplastic Sclerosis

Pathology. The small arteries, arterioles and capillaries are chiefly affected, and there is often some fibrosclerosis. Hyaline degeneration occurs in the intima of the arterioles, especially in the kidneys, spleen, brain, pancreas, liver and adrenals. The parent arteries show intimal thickening from proliferation of the subintima. In the capillaries the endothelium swells and degenerates. Fibroid myocarditis and chronic nephritis are often present in adults, and renal disease in children (see also p. 484).

Endarteritis Obliterans

There is narrowing of the smaller arteries in the extremities, due to proliferation of endothelial cells. This may result in ulceration or gangrene in the digits. The cause is unknown, it is met with in syphilis, at times in tuberculosis, in rickettsial infections, after injuries and in frost bite. The arterial circulation in the limbs is normal, and the pedal pulses are palpable when the toes are affected. The arms are affected more often than the legs.

Clinical Findings in Arteriosclerosis

The patient is usually a male past middle age. The onset of the disease is insidious and nothing abnormal may be noticed, beyond a slight pallor in some cases, until the arterial changes produce symptoms definitely located to some portion of the body. In other cases, when there is a diffuse thickening taking place in the various arteries of the body, the patient may complain that he is becoming prematurely old and unfit for the activities to which he has been accustomed. The effects produced by arteriosclerosis vary with the type of pathological change present, but clinically they are best considered regionally. The blood pressure is usually raised and the heart hypertrophied, but in senile arteriosclerosis this is often not the case, and it is not necessarily so in atherosclerosis. The condition of the arteries may be judged clinically by palpating those which are superficial, such as the radial,

discovered on routine examination without the patient having any symptoms.

Rise of blood pressure may be due to : 1. *Cardiac factors* : An increased stroke output may be due to various conditions, such as an anxiety state, aortic reflux or thyrotoxicosis. Less often it results from adherent pericardium, complete heart block, patent ductus arteriosus or an arterio-venous aneurysm. 2. *Peripheral factors* : The peripheral resistance varies with the condition of the arteries, arterioles, capillaries and veins, and with the volume and viscosity of the blood. Thickening and loss of elasticity of the arteries, arteritis, arteriolar thickening and spasm all tend to cause a rise of blood pressure. Increased blood viscosity is met with in the polycythæmia hypertonica of Gaisbock.

Hypertension may be acute or chronic. *Acute hypertension*. This is met with in acute glomerulonephritis and in the toxæmia of pregnancy. In both of these the rise of blood pressure is associated with salt and water retention, and in the majority of cases the hypertension is only temporary, although occasionally it passes into a chronic phase.

Monoamine-oxidase Inhibitors. These include drugs used for the treatment of depression, such as tranlycypromine (Panate), or combined with trifluoperazin (Parstelin), phenelzine (Nardil) and iproniazid (Marsilid). If yeast, marmite, cheese, game, broadbeans or Chianti wine are taken with these drugs hypertensive crises or even cerebral hæmorrhage may ensue.

Cheddar cheese for instance contains tyrosine which is probably converted into tyramine, a poisonous substance.

The monoamine-oxidase inhibitor drugs prevent the oxidative deamination of tyramine to a harmless substance and the noxious pressor amine, tyramine remains. The pressor effects result from the release of adrenaline and noradrenaline, the catecholamines.

Tranlycypromine should not be prescribed with adrenaline, ephedrine, pethidine, reserpine or guanethidine.

It should be noted that hypotensive collapse may be provoked by some monoamine-oxidase inhibitors such as paraglyne hydrochlor. (Eutonyl) and mebanzine (Actomol).

Chronic hypertension. This may be due to 1. *Renal causes*. These are the most common known causes of hypertension, including chronic pyelonephritis, chronic glomerulonephritis, congenital polycystic disease of the kidneys, congenital renal hypoplasia, and some tumours. Disturbance of the renal circulation, causing ischæmia, also results in high blood pressure. This may be due to coarctation of the aorta, to arteritis resulting from polyarteritis nodosa, systemic lupus erythematosus, or to thrombo-angiitis obliterans. It may also be associated with renal vein thrombosis, renal artery aneurysm or sclerosis, or hypoplasia of the renal artery.

Chronic pyelonephritis is an important cause of hypertension in children and young people, which may be easily overlooked, as there may be nothing suggesting a renal lesion. A retrograde pyelogram and catheterisation of the ureters, with microscopical examination of the

Treatment. This is in the main that of high blood pressure (see p. 285).

For intermittent claudication, the patient should be given tolazoline (Priscol) by mouth, beginning with 25 mg. t.i.d. This may afford great relief. Alternatively, methanesulphonates of dihydroergocornine (Hydergine) may be administered, the patient taking 3 to 8 tablets (0.25 mg. of the active ingredients in each) daily sublingually, and 1 ml. being injected subcutaneously one or twice a week. With improvement the dose may be reduced to 1 to 3 tablets a day. In addition, hot baths, massage and passive vascular exercises (see p. 290) are of value.

Pulmonary Arteriosclerosis

(Pulmonary Atheroma. Ayerza's Disease. Cardiacos Negros)

There are two main groups of cases: 1. Due to primary changes in the pulmonary artery and its branches. 2. The changes in the pulmonary artery are secondary to changes in the lungs and heart, such as chronic bronchitis, emphysema and mitral stenosis. The primary form may be due to a syphilitic infection of the pulmonary artery, but there is a non-inflammatory sclerosis occurring in younger people, the cause of which is unknown. Ayerza's case was secondary to long-standing disease of the lungs.

The clinical picture resembles that described under Pulmonary Heart Disease.

Phlebosclerosis

Hardening of the veins may occur in association with varicose veins, in thrombo-angiitis obliterans, in arterio-capillary fibrosis, and in diabetes mellitus. The pulmonary veins may be affected in mitral stenosis.

Thrombosis of the Axillary Vein

This may occur in healthy young adults as the result of a sudden strain made with the arm and hand; rarely it develops spontaneously. It may be due to pressure of the costocoracoid ligament and subclavius muscle when the arm is abducted. The affected arm swells and is cyanosed, and dilated superficial veins appear on the arm, in the axilla and over the anterior part of the chest. The arm should be rested, elevated, and anticoagulant treatment given (see p. 191).

High Blood Pressure

Definition. Increased blood pressure from any cause.

Physiology and Pathology. The maintenance of blood pressure depends mainly on two factors, the cardiac output and the peripheral resistance. Transitory changes in blood pressure may result from emotion, pain, exercise, angina pectoris, or a tabetic crisis. The average blood pressure reading between the ages of 18 and 40 is 120/80 mm. Hg. Later in life the pressure may rise to 140/90 mm. Hg. A diastolic pressure permanently over 90 mm. Hg. in a young person is likely to be abnormal. The pressure tends to rise in old age owing to loss of elasticity in the arteries. Permanent high blood pressure is often

benign, and severe or malignant. *Benign hypertension.* Here the onset is insidious, the blood pressure being found to be raised at a routine examination, without the patient being aware of any symptoms referable to it. The blood pressure reading is often variable in the early stages; later it becomes permanently raised. After some years the patient may complain of various symptoms, such as tinnitus, headache, palpitations, dyspnœa on exertion, giddiness, lack of concentration, irritability, numbness, tingling, cramp or coldness affecting the legs or transient visual disturbances. *Severe hypertension.* The severe symptoms often appear in the third or fourth decade. A patient who has been known to have a high blood pressure for some years, suddenly, and comparatively rapidly, deteriorates. The main effect may fall on the heart, the kidneys, the eyes or the brain.

On Examination: The physical signs depend upon whether the hypertension is benign or severe, as described below.

Course and Complications. The course in *benign hypertension* is prolonged, often for 10 or 20 years. Death may eventually occur from cardiac failure, cerebral hæmorrhage, or from some intercurrent disease. Women are less adversely affected by hypertension than are men. In *severe hypertension* heart failure may rapidly ensue. Hypertensive cerebral attacks are not uncommon. In one form, which is more prone to develop in patients under the age of 40, there is cerebral œdema, with severe headache, vomiting, drowsiness, and possibly coma. The retinal arterioles are constricted early in the attack. The diastolic pressure may rise to 160 mm. Hg. The blood nitrogen figures are normal, unless the kidney function has also failed. The second variety is more common in individuals over the age of 40, and is probably due to angiospasm. The patient suddenly becomes unconscious in an epileptiform attack. There may be a preliminary cry. This may be followed by coma, or there may be transient aphasia, monoplegia or hemiplegia. In other cases there are papilloedema, retinal hæmorrhages and exudates, and death ensues from cardiac or renal failure. The retinal changes are classified as *Grade I.* Narrowing of retinal arteries. *Grade II.* Narrowing of retinal arteries and nipping of veins. *Grade III.* In addition, retinal hæmorrhages and exudates. *Grade IV.* In addition, blurring of disc. Cerebral hæmorrhage is a terminal event in other instances. Probably about 55% of patients suffering from hypertension die from cardiac failure, 35% from cerebral hæmorrhages or encephalopathy, and 10% from renal failure.

Prognosis. This is difficult to assess in any individual case, unless signs of malignant hypertension are present.

Treatment. In the early symptomless stages no strict regime is necessary. Violent exercise should not be taken. The patient should avoid over-fatigue, late hours and excess of tobacco, alcohol or food. No special diet is required. When symptoms due to hypertension appear, the treatment includes analgesics such as aspirin to relieve headache, and the regular daily administration of tab. phenobarb. et theobrom. (B.P.C.) 1 mane, a salt-poor diet to reduce blood pressure, various drugs to lower blood pressure, and in some cases a surgical

specimens obtained, should be carried out in unexplained cases of hypertension in this age group.

Hypertension is, in some cases, related to unilateral renal lesions, especially the small atrophied kidney following chronic pyelonephritis. Other causes include hydronephrosis, hypoplastic kidney, stone, radiation nephritis, cysts of the kidney, arterial stricture, papilloma of the renal pelvis, aneurysm of the renal artery, and tuberculosis, etc. Removal of the affected kidney may result in a satisfactory fall in the blood pressure.

2. *Endocrine causes:* The adrenal. Carcinoma, adenoma, or hyperplasia of the cortex, result in salt and water retention. From time to time in cases of phæochromocytoma (see p. 713) there is a sudden outpouring of adrenaline and noradrenaline into the circulation causing a paroxysmal rise of blood pressure. The pituitary. In Cushing's disease the hypertension results from excessive production of corticotrophin (ACTH) stimulating the adrenal cortex. The rise of blood pressure which may occur at the menopause is probably due to endocrine disturbances.

3. *Cerebral causes:* These include tabes dorsalis, basilar artery insufficiency, and a ball-valve tumour intermittently obstructing the outflow from the lateral ventricles.

4. *Hyperuricæmia.*

Essential Hypertension

(*Hyperpiesia*)

Definition. A condition of hypertension of unknown origin, usually not associated with demonstrable renal insufficiency.

Etiology. The cause is unknown. Hypertension can be caused by renal artery sclerosis, leading to renal ischaemia. The ischaemia results in an over-production of renin. It is suggested that renin secretion results from diminished plasma volume in the afferent glomerular arterioles. This is detected by stretch reflexes in the glomerular wall. It is a proteolytic enzyme which acts on plasma alpha-globulin to form angiotensin. Angiotensin stimulates the secretion of aldosterone from the adrenal, and the hyperaldosteronism leads to hypertension. Experimentally, removal of a kidney which has been rendered ischaemic is followed by a fall of blood pressure. The high blood pressure does not result in any increase of general circulatory efficiency. *Predisposing causes:* 1. Age: 30 to 50 years. 2. Sex: Females predominate slightly. 3. Heredity: There is a definite familial incidence.

Pathology. Post-mortem examination usually reveals cardiac hypertrophy, the left ventricle being affected. Various arterioles in the body show arteriolosclerotic changes, especially in the kidneys, spleen, pancreas, liver and brain. The kidneys may show granular changes with an adherent capsule.

Clinical Findings. Cases of essential hypertension fall into two groups, according to the evolution of the disease; they are mild or

Methoserpidine (Decaserpyl) 5 or 10 mg. tab. may be given in daily doses of 10 to 60 mg.

4. *Elicitation of the Bezold reflex.* This reflex passes from the myocardium by the vagus to the mid-brain. There is slowing of the pulse, fall of blood pressure and some peripheral vasodilation. The veratrum alkaloids are examples.

Veriloid. This is an alkaloid derived from veratrum viride. The dose is 2 mg. 4 times a day. The effective hypotensive dose of the veratrum alkaloids is very close to the emetic dose.

5. *Post-ganglion sympathetic nerve or nerve endings blocking reagents.*

Bretylium tosylate (Darenthin). This is put up in 200 mg. tablets. The dose is 200 mg. t.i.d. on the first day, increasing daily by 100 mg., i.e. 300 mg. t.i.d. to 600 mg. t.i.d. It may cause severe giddiness or sudden falls in blood pressure. The blood pressure should be taken four times daily, with the patient standing and lying.

Guanethidine (Ismelin). This is long acting and only one daily dose is required. It is put up in 10 and 25 mg. tablets. The dose is increased by 10 mg. each week up to about 60 mg.

6. *Drugs potentiating the action of hypotensive drugs.* These include chlorothiazide and hydrochlorothiazide.

7. *Decarboxylase Inhibitor.* Methyldopa inhibits the biosynthesis of adrenaline and noradrenaline and also of other aromatic amines. Its mode of action is uncertain. Methyldopa (Aldomet). A 250 mg. tab. may be given t.i.d., the dose being gradually increased, if required. The average dose is 2 tabs. t.i.d. Reactions include psychic disturbances, dryness of mouth, diarrhoea, postural hypotension, various rashes, liver damage, blood dyscrasias, fluid retention, drug fever, rise of blood urea, and in one case of mine an attack of tetany, never before experienced, followed the administration of one tablet.

Potent hypotensive drugs should not be given with a raised blood pressure and renal failure. The most important indication for treatment is malignant hypertension. The blood pressure should not be lowered in the elderly as this may lead to minor strokes.

Surgical treatment. Bilateral splanchnicectomy may be beneficial in a small number of cases. In the Smithwick operation the ganglionectomy is from Th.9 to L.3. It is performed transdiaphragmatically in two stages. The patient should be under the age of 50. The main indications are severe hypertension, a blood pressure of 200/120 mm. Hg. or more, which does not improve with rest, and an absence of renal or myocardial disease or of generalised arteriosclerosis. Retinal changes such as exudates and hæmorrhages, are not contra-indications in themselves, and in successful cases they have proved to be reversible. Further, the blood pressure should not be fixed, i.e. it should approximate to normal during sleep, under light Pentothal Sodium anaesthesia, or with continuous caudal anaesthesia; the latter appears to be a more reliable test. Thus the resting pressure before operation may be 200/130, with Pentothal Sodium 100/125, with caudal anaesthesia 140/90, and after sympathectomy 180/90. After the operation there may be a temporary postural hypotension and postural tachycardia. The blood pressure is

operation. The sodium content of various articles of food is given on p. 673. The following articles should be avoided: Cheese, bacon, ham, meat pies, sausages, tinned meats, tinned soups and tinned fish, chocolate, ice cream, soups, rennet, Oxo, Bovril, baking powder, sodium bicarbonate, bottled sauces, pickles, and mayonnaise. Flavourings which may be taken include vinegar, herbs, bay leaves, pepper, garlic, curry, onions, lemon, mustard, salt-free Marmite, parsley, sage, ginger, nutmeg, and cloves. Wine may be used in cooking. In many cases, if a patient will keep steadfastly to a low salt diet, the symptoms of hypertension, provided they are not of the malignant variety, can be relieved, the blood pressure lowered and the health much improved.

Hypotensive drugs. These act in various ways.

1. *Ganglion blocking reagents.* The methonium salts produce their effect by blocking the transmission of impulses at autonomic nerve ganglia. The blockage of the sympathetic ganglia lowers the blood pressure, but the parasympathetic ganglia are also affected, which may result in dryness of the mouth, blurred vision, constipation, impotence, retention of urine, etc.

Hexamethonium bromide (Vegolysen) may be given by injection or orally, best combined with reserpine. It is preferable only to give it by injection. The patient should be in bed and under medical observation in the early stages of treatment. The initial dose for intramuscular or subcutaneous injection is 12.5 to 25 mg. On the next day this dose can be repeated every 8 hours, on the third day every 6 hours, and on the fourth day every 4 hours, the dose being gradually increased until about 500 mg. are given in divided doses daily. The drug is put up in 1% 2.5%, 10% and 30% solutions for injection.

Pentapyrrolidinium bitaltrate (Ansolysen) is perhaps preferable to hexamethonium. It is put up in 10 mg. and 40 mg. tablets. The initial dose is 10 mg., increased daily by 10 to 20 mg. The amount required is usually between 20 to 100 mg. a day, but in some cases as much as 700 mg. a day may be given. It should be dissolved in water and taken half an hour before meals. It may give rise to postural hypotension, paralytic ileus, difficulty in micturition, dryness of the mouth, or weakness of ocular accommodation.

2. *Action on centres in brain and on peripheral vessels.* *Hydrallazine* (Apresoline) acts centrally. It is given by mouth in doses of 25 mg. every 4 to 6 hours. It is not advisable to give this drug in cases of severe hypertension.

The blood flow through the kidney is increased and the diastolic pressure is affected more than the systolic. Side effects include tachycardia, fever, and a rash.

3. *Action on thalamic centres.* The tissues are depleted of 5-hydroxytryptamine and of noradrenaline, but this may be due to a peripheral effect depleting the body stores.

Rauwolfia serpentina. The purified alkaloid reserpine (Serpasil) is put up in 0.25 mg. tablets. This is given 3 to 4 times a day at the beginning of treatment, and reduced to a maintenance dose of about 0.5 mg. a day. Reserpine may cause depression and fluid retention.

lowered permanently in about 15% of cases, but the patient is often symptomatically better although the blood pressure remains raised.

Low Blood Pressure (*Hypopiesis. Subtension*)

Definition. Diminished blood pressure from any cause.

Etiology. Low blood pressure may be physiological and unassociated with any symptoms of ill health. It may be postural, due to a failure of the blood pressure regulating mechanism, as is seen in soldiers on parade standing for long periods at attention, or when patients take hypotensive drugs. Secondary hypotension may be met with in wasting diseases, chronic infections and hypothyroidism. It may be due to Addison's or Simmonds' disease, to hyperinsulinism, shock, hæmorrhage, coronary occlusion, neurocirculatory asthenia or to a hypersensitive carotid sinus.

Pathology. The low blood tension is usually due to capillary dilatation, and in some cases the blood is pooled in the splanchnic area.

Clinical Findings. A low blood pressure may be an acute and temporary state, which shows itself by fainting and loss of consciousness. In other cases it is persistent, the patient complaining of lassitude, insomnia, headache and giddiness. In some cases there are no symptoms, as 8% of over 2,000 fit air pilots in England were found to be hypotensive.

On Examination: The blood pressure in an adult is considered to be low if the systolic reading is below 110 mm. Hg.

Treatment. The blood pressure can be raised very temporarily by a subcutaneous injection of inject. adrenaline (B.P.) 1 in 1,000, 8 to 15 m. (0.5 to 1 ml.). Ephedrine sulphate tablets, $\frac{1}{2}$ gr. (45 mg.), may be given by mouth, t.d.s. or amphetamine sulphate 10 to 20 mg. daily in the morning. A well-fitting abdominal binder may be helpful.

For anæmia, iron or liver extract should be given according to the type of anæmia present. Any of the associated conditions mentioned above require their special treatment.

Thrombo-angitis Obliterans

(*Thrombotic phlebo-arteritis. Buerger's Disease. Von Winiwarter's Disease. Die Hebraische Krankheit*)

Definition. A disease characterised by thrombosis of portions of arteries and veins in the extremities, with an inflammatory reaction around the affected vessels.

Etiology. The cause is unknown. *Predisposing causes:* 1. Age: 25 to 50. 2. Sex: Chiefly males. 3. Heavy cigarette smoking. 4. Race: Chiefly Jews.

Pathology. Thrombosis occurs segmentally in the larger arteries of the legs and in the superficial veins. There is some organisation of the clot, and an inflammatory reaction around the vessels with fibrous tissue formation, which may also involve the nerves.

Clinical Findings. The patient is usually a male between the ages

of 25 and 50 years. The onset often occurs in cold weather, with numbness, coldness, or pain in the foot or leg, induced by walking and relieved by rest. Later, the pain becomes more severe and occurs apart from exertion (rest pain). This indicates that the arterial blood supply and collateral circulation are grossly impaired and insufficient for the nutritional needs of the skin. After a year or so the other leg is affected and later it may spread to the fingers and hands. Sleep may become impossible owing to pain, which is intensified when the leg is elevated. Painful spots may also be noticed which are due to superficial venous thrombosis.

On Examination: In a developed case the leg is red and shiny when dependent, and pale on elevation or on lying down; no pulsation can be felt in the dorsalis pedis or posterior tibial artery. The foot or leg feels cold and the skin temperature is lower than that of the unaffected leg. With an oscillometer accurate readings can be obtained of the difference in the blood pressure in the two legs; the cuff can be placed above the knee and ankle. Thrombosed superficial veins may be seen and felt, their site varying from time to time. There may be small blisters containing bloodstained fluid on the toes, ulcers often form under the big toe nail, and œdema of the foot, or actual gangrene of the toes may ensue. There is no muscular wasting and no sensory changes are present. The determination of the skin temperature and the response to heat or to a spinal anæsthetic are of great importance in deciding the amount of vasoconstriction which can be overcome by sympathectomy. They are an index of the amount of muscular tissue as compared with fibrous tissue in the arteries. Alternatively they may indicate the degree to which the circulation is increased owing to vasodilatation of the healthy vessels. The blanket method is a convenient way of performing the test. The patient lies naked, except for a loin cloth, in a room with a constant temperature of 78° F. (25.5° C.) for an hour. The skin temperature is then taken, with a special mercury thermometer or a thermocouple connected with a delicate galvanometer, at the following points: Mouth, axilla, elbow, wrist, interdigital spaces, tips of digits, groin, knee, ankle, interdigital spaces, tips of digits (on both sides of the body). The patient is then wrapped, except for his face, in a warmed light rubber sheet, and covered by three blankets. After one hour the skin temperatures are again taken at the same points and the results are recorded on a graph. Normally, or if there is little vasospasm, the second graph is almost a straight line, at or slightly below the mouth temperature level. When a limb has arterial obstruction the skin temperature is some degrees lower than that of a normal limb, and, on raising the temperature around the body the rise in skin temperature is proportional to the capacity of the superficial vessels to dilate (see Fig. 19).

Differential Diagnosis. The disease must be differentiated from Raynaud's disease, erythromelalgia, arteriosclerotic endarteritis obliterans, thrombo-phlebitis migrans, popliteal aneurysm, neuritis, flat foot and rheumatism. In Raynaud's disease there is no dependent rubor, no venous thrombosis, and the arterial pulse is present. In erythromelalgia there is no phlebitis, no claudication, no gangrene,

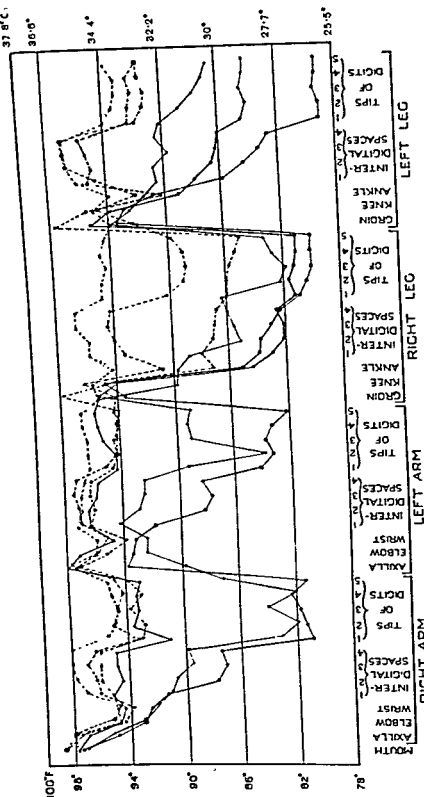


FIG. 19. SKIN TEMPERATURES IN HEALTH AND IN THROMBO-ANGITIS OBITERANS.

— Normal person after one hour at room temperature of 78° F. (25.5° C.).
 Normal person after wrapping in blanket for one hour at room temperature of 78° F. (25.5° C.).
 — Patient after one hour at room temperature of 78° F. (25.5° C.).
 Patient after wrapping in blanket for one hour at room temperature of 78° F. (25.5° C.).
 — Patient after two months' Carnation treatment and after one hour at room temperature of 78° F. (25.5° C.).
 Patient after two months' Carnation treatment and after wrapping in blanket for one hour at room temperature of 78° F. (25.5° C.).

Clinical Findings. Recurrent attacks of phlebitis occur usually in the legs. The patient may have symptoms suggesting thrombosis in the lungs, the abdomen, the heart or the brain. Thus he may be attacked with acute pain in the chest, and cough up some rusty sputum, or he may have severe abdominal pain, or cardiac pain or symptoms of a cerebral thrombosis. The temperature is usually elevated with each recurrence of thrombosis, and the blood shows a leucocytosis.

Prognosis. This is usually favourable, even when thrombosis occurs in internal organs, although there is a tendency to recurrence.

Treatment. The patient must be kept in bed. Plenty of fluids should be taken by mouth, and a course of anticoagulants given (see p. 191). Subsequently the teeth should be X-rayed and any septic focus eradicated.

Takayasu's Arteriophagy

(Pulseless Disease)

This is essentially a generalised disease in which the aorta especially and its branches undergo obliterative arteritis with intra-arterial thrombosis. It affects chiefly young women. In the early stages the pulses are not affected, but the sedimentation rate of the red cells is increased and the disease may be mistaken for systemic lupus erythematosus. Murmurs, if listened for, are usually heard over the carotids or abdominal aorta, which should differentiate.

Later, there is absence of arterial pulsation in the arms, and at times in the carotid and superficial temporal arteries. There may also be retinal vascular changes and attacks of syncope. In some cases there is intermittent claudication with absence of arterial pulsation in the legs. The disease is usually fatal unless diagnosed early before the pulseless stage, when anticoagulant and/or corticosteroid treatment may arrest its progress.

Erythromelalgia

(Weir Mitchell's Disease)

Definition. A disease characterised by redness, heat and pain of the extremities, especially the feet, which are worse when they are dependent.

Etiology. The cause is unknown. It may be associated with exposure to cold and wet, or with much walking.

Pathology. The vascular changes may be due to a disorder of the sympathetic nervous system.

Clinical Findings. The patient is usually an adult woman between the ages of 30 and 50. She first notices pain in the soles of the feet after standing or walking. The pain is of a burning character and later may be very severe, occurring also in bed (rest pain) when the feet are hot. It is usually worse in the summer, but there is no claudication.

On Examination: One or both feet are red, and the lower half of the leg may also be affected. The foot feels hot. Pain is experienced

the arteries pulsate normally, and the limb does not blanch markedly on elevation. In arteriosclerotic endarteritis calcification of the arteries can be felt, or seen with the X-rays, there is no migrating phlebitis, and the age incidence is usually later. In thrombo-phlebitis migrans there is no claudication and no arterial obliteration. It is possible, however, that some cases are early stages of thrombo-angiitis obliterans. Many cases are diagnosed in the initial stages as flat foot or rheumatism, and so much valuable time is lost.

Course and Complications. The course is usually prolonged for 10 years or longer; there is a tendency for the disease to spread from limb to limb, but pulsation may return in the affected artery. Thrombosis may occur in the mesenteric, cerebral, renal or coronary arteries. Acute fulmination may occur with œdema and gangrene of the limb.

Prognosis. This is unfavourable; death is usually due to an intercurrent disease.

Treatment. At the onset the patient should be kept in bed and smoking forbidden. Any septic focus should be treated. Local treatment consists in passive movements to the leg. It is raised to produce blanching for 3 minutes, and then hung over the edge of the bed to effect rubefaction for 5 minutes, and finally it is kept horizontal for another 5 minutes. This exercise is repeated several times daily. For rest pains the leg should be kept below the horizontal, and relief obtained by hanging it down over the side of the bed. Heat intensifies rest pains. Vasodilator drugs may be tried, such as nicotinic acid tab. 50 mg., in daily doses sufficient to produce flushing and tingling of the face, neck, back or hands. As much as 500 mg. a day in divided doses may be needed. Tolazoline (Priscol) tab. 25 mg. or aminophylline (Cardophyllin) tab. 0.1 G. may be taken by mouth 4 times daily. Intravenous hypertonic saline injections are successful in some cases, 300 ml. of 3% NaCl solution being injected intravenously every other day. As an alternative to this the patient may drink daily 3 to 4 quarts (3.6 to 4.5 litres) of water containing 10 G. of table salt to 1 quart (1.2 litre). Muscle extracts have proved beneficial in the treatment of some cases, a preparation such as Carnacton being used. 1 to 2 ml. are injected intramuscularly three times a day for several months. The beneficial results of such treatment can be seen by the skin temperature curve in Fig. 19. Anti-coagulants (see p. 191) may be used for an acute thrombotic episode. Tolbutamide in doses of 0.5 G. tab. t.i.d. with food has been found to relieve pain, œdema and inflammation in some cases. Surgical treatment consists in lumbar sympathectomy with bilateral removal of the 2nd to 4th L. ganglia. The operation will only remove spasm, and should therefore only be employed if the skin temperature tests indicate that the vessels are still capable of dilatation. In cases of gangrene or pain unrelieved by other methods, amputation alone can afford relief.

Thrombo-phlebitis Migrans

Definition. Phlebitis of the superficial veins, recurring in different sites and often accompanied or followed by venous thrombosis in internal organs.

may occur in the fingers, toes, ears or nose. The affected parts may sweat and sensation may be blunted.

Differential Diagnosis. It is not uncommon in women for one or more fingers to become suddenly white and "dead," usually when there is a slight fall in the temperature. Such a condition rarely, if ever, leads to Raynaud's disease. The criteria for making a diagnosis of Raynaud's disease are episodes of bilateral peripheral vasospasm produced by cold or emotion, usually without gangrene or with only minimal grades of cutaneous gangrene. It is not secondary to a primary disease such as arteriosclerosis, thrombo-angiitis obliterans, cervical rib or nervous disease, and the condition has persisted for 2 years or longer. Secondary Raynaud's phenomenon may be associated with a variety of causes, which include local trauma, vibration from pneumatic drills, ergot poisoning, collagen diseases such as systemic lupus erythematosus and dermatomyositis, thrombo-angiitis obliterans, arteriosclerosis, cold hæmagglutination, polycythæmia, etc.

Course and Complications. The course is usually progressive for a time. Trophic changes which may develop in severe cases include sclerodactyly, ridging of the nails, blister formation, and small local areas of gangrene in the finger tips. More extensive gangrene is uncommon.

Prognosis. This is variable, but the condition may disappear after several years.

Treatment. Prophylactic. In the secondary Raynaud's phenomenon due to pneumatic drills the workers should have their hands protected by sorbo shock absorbing pads placed in the palms of their gauntlets. The use of gloves or rubber pads interferes with the accurate control of more delicate instruments. In view of the long incubation period, it has been suggested that no one should be employed in this type of work for longer than 9 months.

Curative. The extremities should be protected from cold. A warm climate is very beneficial. Smoking is forbidden. Phenoxybenzamine (Dibenzylene) may afford relief in doses of 10 mg. caps., one at night for a week. Then one morning and evening for a week. The daily dose may now be increased by 10 mg. at weekly intervals up to 100 mg. a day providing postural faintness does not occur. It should not be given to patients with cardiac disease or subject to faints, or to those who have had a sympathectomy. Massage and electrical treatment with galvanism or high frequency should be tried. In severe cases affecting the lower limbs, the operation of lumbar sympathectomy may afford a cure if the vessels are still capable of dilatation. When the upper limbs are affected the results of excision of the stellate ganglion, in which post-ganglionic fibres are divided, are not so good as in lumbar sympathectomy in which pre-ganglionic fibres only are divided. A pre-ganglionic sympathectomy, in which the sympathetic trunk is divided below the third thoracic ganglion, and the second and third thoracic somatic nerves are divided at the vertebral foramina, is preferable therefore to stellate ganglionectomy, and avoids the development of a Horner's syndrome.

when the surface temperature reaches 93° F. (34° C.). There is no oedema and no gangrene. The foot does not become much more red when dependent, nor does it blanch considerably on elevation. The arterial pulsation and sensation are normal.

Differential Diagnosis. Erythromelalgia must be differentiated from Raynaud's disease, and painful rubor associated with thromboangiitis obliterans and arteriosclerosis affecting the extremities. The differential diagnosis is considered on p. 289.

Course and Complications. The disease is usually progressive, but complications are rare. Both hands and feet may eventually be affected.

Prognosis. The chance of spontaneous cure is remote and the disease usually persists for many years.

Treatment. Early and prolonged rest is of the greatest importance. Relief has been obtained by methysergide (Deseril) 2 mg. tab. t.d.s. This has an anti-serotonin action, but no evidence has been produced of the over-production of serotonin in this disease.

Raynaud's Disease

Definition. Raynaud's disease is a primary or idiopathic condition characterised by paroxysmal vasoconstriction of the arteries of the fingers, toes, ears or nose, which results in pallor or cyanosis, with or without local gangrene. These clinical changes are known as the Raynaud phenomenon.

Secondary Raynaud's phenomenon is also met with. In this similar clinical manifestations are present, but they are secondary to trauma, to drugs, or to organic disease affecting the arteries. The causes are referred to below under the heading of "differential diagnosis."

Etiology. *Predisposing causes:* 1. There is a familial incidence. 2. Sex: Females predominate. 3. Age: Usually between 20 and 40 years. *Exciting causes:* Exposure to cold and emotional disturbances, childbirth and the menopause.

Pathology. In the early stages no changes are found in the digital arteries, later there may be thrombotic occlusion. There are two theories as to the pathogenesis, (a) the vasoconstriction is due to sympathetic nerve stimuli; (b) the arteries are locally unduly susceptible to cold.

Clinical Findings. The patient is usually a female between the ages of 10 and 80 years, although many cases have been recorded in males. In a mild case (local syncope) the fingers and toes become suddenly pale and dead, and on warming them they ache or throb. The spasm spreads upwards from the tips of the fingers and toes. In a moderately severe case (local asphyxia) the patient complains of a tingling sensation in the hands when they are cold, and she may drop what she is holding. If the white finger is immersed in warm water it goes blue. One or more fingers go quite blue or black and there is severe pain. The position of the hands does not influence the colour of the fingers in the attacks. The ears or nose may be similarly affected. In a severe case (local gangrene) the pain is almost unbearable, and gangrene, with sloughing,

made for septic foci, in such sites as the teeth, tonsils, antra, sinuses, intestines, kidneys, bladder and genital organs. Any such focus should be adequately treated. The protein cutaneous tests should also be performed. The effect of different diets should be determined, eliminating such articles as milk, eggs, or fish.

Milroy's Disease

(Primary Lymphædema of the Leg. Non-filarial Elephantiasis)

Definition. A disease which is often familial, characterised by swelling of the legs, arms or face.

Etiology. The cause is not known. It is more common in women than in men, and may be noted shortly after birth or not be apparent until after the age of puberty.

Pathology. There is thickening of the skin and subcutaneous tissues. Infection may occur associated with lymphostasis.

Clinical Findings. The patient may say that other members of her family are similarly affected. She complains of heaviness and swelling of the feet and legs. Only one limb may be affected. It is uncommon for the arms or face to be involved.

On Examination : The affected limb is usually pale, swollen and pits slightly on pressure. Lymphangiography shows lymphatic deformity.

Differential Diagnosis. Other causes of swelling of the extremities must be excluded, such as diseases of the heart or kidneys, varicose veins, obesity, intra-abdominal venous obstruction or lymphatic obstruction due to filarial elephantiasis (see p. 774).

Course and Complications. The course is progressive, but it may be interrupted by acute attacks of pain in the limbs accompanied by fever.

Prognosis. The disease is not fatal.

Treatment. The legs should be bandaged from the feet upwards to prevent the swelling from increasing. Kondoléon's operation is sometimes performed with satisfactory results. Strips of œdematous skin, subcutaneous tissue and deep fascia are removed from both sides of the leg, from the upper end of the thigh to the ankle, with an interval of about 3 inches or (7.5 cm.) each side of the knee. Alternatively the œdematous subcutaneous tissues and deep fascia are removed and the underlying muscles covered with a skin graft. Satisfactory results are obtained in about 70% of cases.

Anglo-neurotic Œdema

(Quincke's Disease)

Definition. A condition characterised by paroxysmal attacks of œdematous swelling of the skin, subcutaneous tissues or mucous membranes.

Etiology. The cause is not known. It may be an allergic manifestation or a vaso-motor disturbance. It may occur as an allergic reaction to penicillin.

Pathology. The œdema may result from the local effect of histamine on capillaries.

Clinical Findings. The patient is usually a young adult of either sex, and a history is sometimes obtained of similar attacks in other members of the family. The most serious form, with œdema of the glottis, is often hereditary. He complains of localised swellings appearing suddenly in the face, lips, eyelids, mouth, hands or elsewhere. An urticarial rash may develop simultaneously. The eyelids or lips may swell and become very tense and painful. Thus the eyes may be completely closed. Similar swellings may develop in the tongue or larynx causing urgent dyspnoea. The mucous membrane of the alimentary tract may be affected, the patient complaining of acute abdominal pain with vomiting or diarrhoea.

On Examination : The appearance of the patient may be completely altered during the attacks owing to the swelling. The cutaneous swellings pit slightly on pressure, the skin is generally white, but may be a little pink.

Differential Diagnosis. Other varieties of œdema, such as that produced by disease of the heart or kidneys, must be excluded. The abdominal variety is suggestive of an acute abdominal lesion, but there is no fever and a history of previous attacks affecting the skin may afford the clue to the diagnosis. A few cases of *spontaneous periodic œdema* have been described, characterised by retention of fluid in the skeletal muscles, and possibly in the cardiac muscle and the lungs, a feeling of heaviness in the limbs and tightness of the skin, swelling of the limbs, weakness and dyspnoea. The urinary aldosterone excretion is increased.

Course and Complications. Recurrent attacks are to be expected. Hæmoglobinuria may be a complication.

Prognosis. The patient often outgrows the attacks. Death may ensue from œdema of the glottis.

Treatment. *During the attack :* An injection of 8 to 15 m. (0.5 to 1 ml.) of inject. adrenaline (B.P.) 1 in 1,000 should be given subcutaneously. Antihistamine drugs, such as Thephorin tab. 25 mg., or Pyribenzamine 50 mg., may be taken by mouth, two or three daily. In severe cases prednisone may be given by mouth, beginning with 40 mg. a day, in divided doses, and reducing gradually to 5 or 10 mg. daily. With œdema of the glottis a nebuliser containing neb. isoprenal. (B.P.C.) should be used. Tracheostomy or intubation of the larynx may be necessary to save life. *Between the attacks :* A search should be

through the mid-brain, pons and medulla oblongata, the corticonuclear fibres cross the mid-line and end in arborisations in grey matter from which the second relay connects with the dendrites of the motor cranial nerve nuclei.

On tracing the corticospinal tract still lower, there is, at the level of the lower part of the medulla oblongata, a decussation (decussation of the pyramids) affecting 90% of the fibres. The fibres after decussation are known as the lateral corticospinal (crossed pyramidal) tract, and they

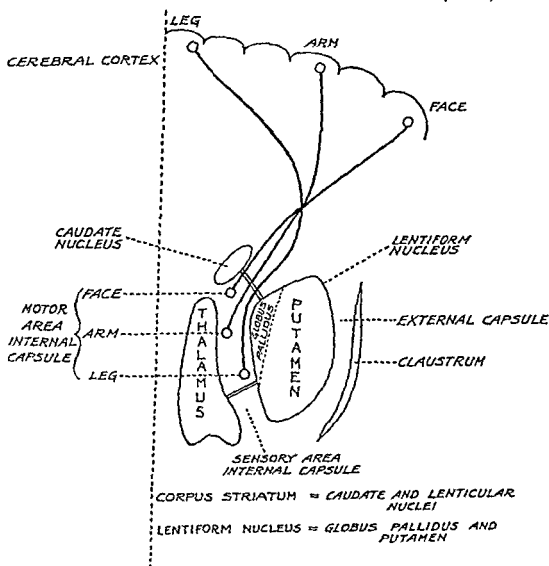


FIG. 20. DIAGRAM SHOWING THE INTERNAL CAPSULE AND CORPUS STRIATUM.

run down the spinal medulla (cord) in the lateral regions (see Fig. 21). The 10% of fibres which have not decussated form the anterior corticospinal (direct pyramidal) tract and pass down the anterior part of the spinal medulla (cord) near the median fissure as far as the lower cervical or mid-thoracic region (see Fig. 21). The fibres of the lateral corticospinal tract are connected with posterior horn cells, and then by a second relay with the motor cells in the anterior horn of the grey matter of the spinal medulla (cord). These are the cells of origin of the lower motor neurones, from which nerve fibres proceed direct to the skeletal muscles.

CHAPTER IV

THE NERVOUS SYSTEM

Introductory. Every patient who is suspected to be suffering from a disorder of the nervous system should be examined in accordance with a definite plan, as detailed later (see p. 302). An elementary knowledge of the anatomy and physiology of the nervous system is essential.

Anatomy and Physiology

The Motor Path from the Cerebral Cortex to the Muscles. Voluntary muscular movements are initiated by impulses arising in the cerebral cortex, and passing to the mid-brain, pons, medulla oblongata and spinal medulla (cord). From these lower levels fresh fibres arise and pass direct to the muscles concerned. It is believed that there are three relays of fibres between the cerebral cortex and the muscles, as described below. The motor cortical area lies in the frontal lobe of the brain on each side just anterior to the central sulcus (fissure of Rolando), see Fig. 33. The motor fibres converge and pass through the genu and anterior two-thirds of the posterior limb of the internal capsule of the brain. This is the portion of white matter which lies between the thalamus and the lentiform nucleus. It will be noticed (see Fig. 20) that in the convergent movement the fibres for the leg cross those of the arm and come to lie posteriorly, whereas the face fibres also cross the arm ones to become anterior, the arm fibres being situated centrally. The order of fibres in the internal capsule is therefore, from before backwards, face, arm, leg.

The upper motor neurones consist of the corticospinal and corticonuclear fibres (the pyramidal tract). They emerge from the internal capsule and run through the mid-brain, pons and medulla oblongata, near the ventral surface, in a bundle called the pyramid. Certain cranial motor nerves have their cells of origin in this part of the brain. Thus the nucleus of the III nerve lies at the level of the superior colliculi (corpora quadrigemina) (see Fig. 37), and that of the IV nerve in the region of the inferior colliculi (corpora quadrigemina) (see Fig. 38). The motor nucleus of the V nerve is in the middle of the pons, and the VI and VII nuclei in the lower part of the pons. The IX, X, XI and XII nuclei are in the medulla oblongata (see Fig. 45). It will be noticed that with the exception of the III and IV nerves, the cranial nerves pass to the same side of the body as that on which their nuclei are situated. *Decussation of certain fibres occurs with the III nerve and total decussation in the case of the IV nerve, so that the nucleus of the IV nerve situated on the right side of the brain supplies the left superior oblique muscle, and vice versa.* There is a bilateral cortical innervation for all the cranial nerves except the XII and the part of the VII nerve which supplies the lower part of the face. As the upper neurones pass down

4. *The Striatopallidal Tract.* (The large-celled pallidal system.) The fibres arise in the globus pallidus of the lentiform nucleus and run to the red nucleus on the same side of the brain. The impulses are concerned with emotional and associated movements.

5. *The Small-celled Neostriate System.* Fibres pass from the caudate nucleus and the putamen of the lentiform nucleus to the globus pallidus. They exert an inhibitory influence over the motor impulses arising in the large-celled pallidal system.

6. *The Rubrospinal Tract.* The fibres arise in the red nucleus, which is situated in the mid-brain at the level of the superior colliculi. The fibres immediately decussate and pass down the opposite side through the pons and medulla oblongata and antero-lateral part of the spinal medulla (cord) to end around anterior horn cells. They convey impulses for group movements (see Fig. 34).

Upper Motor Neurone Lesions. Irritative lesions cause convulsive movements of the voluntary muscles.

Paralytic lesions result in paralysis of voluntary movement with spasticity, increase of deep reflexes, ankle and patellar clonus, and an extensor plantar response. The electrical reactions are normal, and wasting is slight. When the upper motor neurones arising in the cerebral cortex are put out of action, the extrapyramidal motor tracts arising in the basal ganglia may show symptoms of uncontrolled activity, which are known as "release" symptoms. Various involuntary movements then ensue, such as are seen clinically in athetosis following a hemiplegia.

Extrapyramidal Motor Neurone Lesions. Lesions of the large-celled pallidal system (globus pallidus), such as occur in paralysis agitans and progressive lenticular degeneration, cause hypertonus of muscles, tremors and disturbance of automatic movements. Lesions of the small-celled neostriate system produce athetoid or choreic movements. Lower motor neurone lesions result in weakness of muscles, wasting, hypotonus, absence of the deep reflexes and a reaction of degeneration.

The Sensory Path from the Periphery to the Brain. 1. *The Spinal Nerves.* In the spinal motor nerves about 40% of the fibres are afferent, conveying sensations which are known as proprioceptive or kinæsthetic, from the muscles, tendons, joints and periosteum. Their cells of origin are situated in the spinal ganglia (dorsal root ganglia). The spinal sensory nerves convey impulses of pain, touch and temperature from the skin. These are called exteroceptive impulses. Enteroceptive impulses pass from the viscera by various spinal nerve roots, and connect with cells in the lateral horn of the grey matter of the spinal medulla (cord). The following impulses enter the spinal medulla by various dorsal root fibres (see Fig. 22). 1. Touch (deep cutaneous), and discrimination of the points of a compass. 2. Muscle sense, as evidenced by judging the differences in weight; stereognosis or judging the nature of objects by feeling them; deep pressure pain; tendon sense; joint sense; bone vibration sense, and the knowledge of the position of the limb in space. 3. and 4. Muscle tonus, equilibrium and co-ordination. 5. Cutaneous

The upper motor neurones in the anterior corticospinal tracts cross the mid-line in the anterior white commissure of the cord and terminate around posterior horn cells. They are connected by a second relay with anterior horn cells. There are thus three relays between the cerebral cortex and the muscles, the upper motor neurones, the intermediate neurones, and the lower motor neurones.

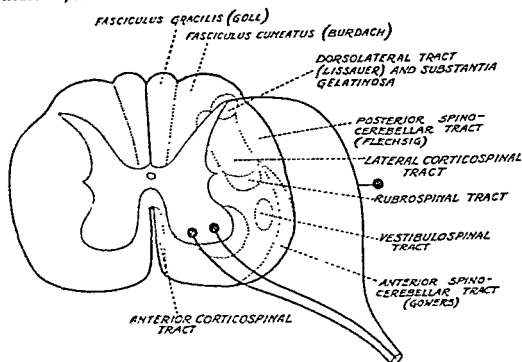


FIG. 21. DIAGRAM OF SECTION OF SPINAL CORD.

The Extrapyramidal Motor Tracts. These tracts convey involuntary motor impulses from various ganglia in the brain to intermediate relay stations, or to the anterior horn cells of the cord. They are concerned with automatic actions and are an older motor system than is the corticospinal one. They function in infants before the corticospinal system is capable of so doing. The most important of these tracts are :—

1. *The Vestibulospinal Tract.* The fibres arise in the lateral vestibular nucleus of the VIII nerve (Deiters' nucleus) in the lower part of the pons and run down the antero-lateral part of the medulla oblongata and cord to end around anterior horn cells on the same side of the cord (see Fig. 34).

2. *The Tectospinal Tract.* This tract arises in the mid-brain at the level of the superior colliculi, and, after crossing in the median raphe it passes down the cord in the ventral aspect of the medial longitudinal bundle to end around anterior horn cells. It conveys impulses to the voluntary muscles (eye protection movements) as the result of stimuli from the eyes which have passed to the calcarine sulcus and thence to the superior colliculi (see Fig. 37).

3. *The Cerebellar Tract.* The fibres arise in a cerebellar hemisphere, and pass by the superior cerebellar peduncle to the red nucleus of the opposite side (see Fig. 34).

fibres from the upper thoracic and cervical nerves. A second relay of fibres now begins which decussates (decussation of the lemnisci) and then ascends the pons and mid-brain as the medial lemniscus to the ventral nucleus of the thalamus. From the thalamus some impulses pass by a third relay to the sensory cerebral cortex in the postcentral gyrus. Other fibres pass from the gracile and cuneate nuclei to the cerebellum by the arcuate fibres which run into the inferior cerebellar peduncle (see Fig. 34).

Impulses 3 and 4. Muscle tonus sensations and impulses for maintaining equilibrium relay first in the dorsal nucleus near the posterior

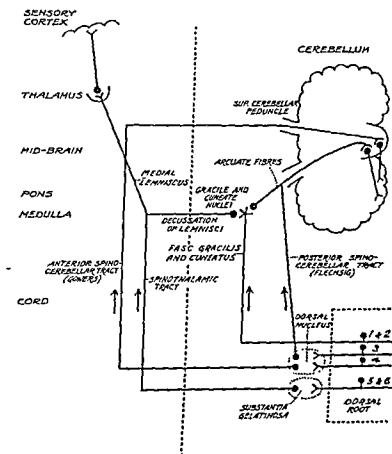


FIG. 23. DIAGRAM SHOWING THE SENSORY PATH.

Fibres in Posterior Root—

1 & 2. Kinesthetic.

3 & 4. Equilibrium.

5 & 6. Pain : Temperature and some touch sensations.

horn of grey matter. The second relay of fibres conveys the impulses either to the posterior spinocerebellar tract on the same side, or cross the mid-line in the grey or the anterior white commissure to the anterior spinocerebellar tract on the other side. The posterior spinocerebellar tract conveys the impulses to the cerebellum on the same side by the inferior cerebellar peduncle, whereas the anterior spinocerebellar tract decussates higher up (see p. 376) and passes to the cerebellum by the superior cerebellar peduncle, on the same side as that on which the impulses entered the spinal medulla (cord).

pain and temperature. 6. Localised touch. 7. Direct cutaneous—muscle reflex path.

1, 2, 3 and 4 are kinæsthetic sensations, 5 and 6 are skin sensations.

2. *The Central Path* (see Figs. 22, 23). *Impulses 1 and 2.* The fibres conveying deep touch, discrimination of compass points, muscle,

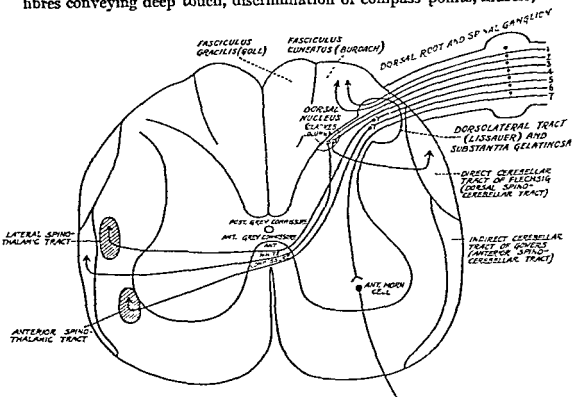


FIG. 22. DIAGRAM SHOWING FIBRES OF A DORSAL NERVE-ROOT ENTERING THE SPINAL MEDULLA (CORD)

Posterior Root Tracts—

- | | |
|---|------------------------|
| 1. Touch (deep cutaneous). Discrimination of points of compass. | } Kinæsthetic stimuli. |
| 2. Muscle sense. Joint sense. Tendon sense. Bone vibration sense. Pressure-pain of muscles. | |
| 3 and 4. Muscle tonus. Equilibrium. Co-ordination. | |
| 5. Pain. Temperature. | |
| 6. Localised touch. | |
| 7. Direct cutaneous muscle reflex. | |

Posterior columns: Muscle sense, such as sense of position of a limb, judging weights, pressure pain.

Stereognostic sense, a combination of touch and joint sense.

Joint sense (position of a joint).

Bone vibration sense.

Tactile, discrimination of two points. Sense of position of skin when pulled out.

Lateral Spinothalamic Tract. Pain and temperature.

Anterior Spinothalamic Tract. Highly localised touch.

Spinocerebellar Tracts. Muscle tonus.

tendon, joint and bone sense pass up the spinal medulla (cord) on the same side in the posterior funiculus. As they ascend they are pushed centrally by new fibres coming in (fasciculus cuneatus) and they now constitute the fasciculus gracilis (Goll). The fibres terminate in the gracile and cuneate nuclei in the lower part of the medulla oblongata. The gracile nucleus is the relay station for fibres from the lower thoracic, lumbar, sacral and coccygeal segments, and the cuneate nucleus for the

- (e) Joint sense.
- (f) Vibration sense.
- (g) Pain, temperature and light touch.
- (h) Subjective sensation.

The Reflexes. (a) *Superficial*.

1. Conjunctival (V).
2. Palatal (IX and X).
3. Pharyngeal (IX).
4. Epigastric (Th. 7-9).
5. Abdominal (Th. 9-12).
6. Cremasteric (L 1 and 2).
7. Plantar (S 1 and 2).

(b) *Deep*.

1. Pupil (II and III).
2. Jaw jerk (V).
3. Biceps (C 5 and 6).
4. Triceps (C 6 and 7).
5. Supinator (C 7 and 8).
6. Knee-jerk and clonus (L 2-4).
7. Ankle-jerk and clonus (S 1 and 2).

(c) *Visceral*.

1. The bladder.
2. The rectum.

Co-ordination. (a) The upper limbs.

(b) The lower limbs.

Trophic Changes. (a) Skin.

(b) Bones and joints.

Gait.

Electrical Reactions.

Electromyography.

Lumbar Puncture.

Myelography.

Ventriculography.

Encephalography.

Angiography.

Electro-Encephalography.

Site of Lesion.

Additional notes on the examination of the nervous system:—The chief segmental nerve supply for some of the important muscles is as follows: C 4. Diaphragm. Trapezius. C 5. Supraspinatus. Infra-spinatus. Biceps. Deltoid. C 6. Pronators of forearm. Latissimus dorsi.

Impulses 5 and 6. Sensations of pain and temperature enter the spinal medulla (cord) by the dorsal root and relay in the substantia gelatinosa. The second relay conveys the impulses to the opposite side of the spinal medulla (cord) through the anterior white commissure and they then ascend in the lateral part of the spinothalamic tract. This joins the medial lemniscus and runs to the ventral nucleus of the thalamus. Some of the impulses are then carried by a third relay to the sensory part of the cerebral cortex (the postcentral gyrus, the superior parietal lobule, the supramarginal and angular gyri), and others pass to the medial thalamic nucleus where they give rise to sensations of pleasure and pain. The fibres conveying the highly localised sense of touch also relay in the substantia gelatinosa. The second relay crosses the mid-line in the anterior white commissure and ascends in the anterior part of the spinothalamic tract. These fibres join the medial lemniscus, and terminate in the thalamus. A final relay conveys the impulses to the sensory part of the cerebral cortex.

The Cranial Nerves (see p. 381). The sensory fibres from the V, VII, IX and X nerves also join the lemniscus.

The Cerebellar Connections (see p. 375).

Nervous Disease Case Sheet

Name. Age. Sex. M.S.W.

Family history of nervous diseases.

Previous history.

History of present illness. Date of onset.

Mode of onset.

General condition. Pulse. Temperature.

Respirations. Urine. Blood (cell count and W.R.). Cerebration.
Speech.

Cranial Nerves. I.

II.

III. IV. VI.

V. Motor. Sensory.

VII. Motor. Sensory.

VIII.

IX. X. and accessory part of XI. Motor. Sensory.

XI. Spinal part.

XII.

Spinal Motor Nerves. (a) Power of muscles.

(b) Wasting or hypertrophy of muscles.

(c) Tone of muscles.

(d) Tremors, fibrillations, spasms or convulsions.

Spinal Sensory Nerves. (a) Tactile discrimination (compass test).

(b) Muscle sense.

(c) Stereognostic sense.

(d) Muscle and tendon pressure sense.

THE NERVOUS SYSTEM

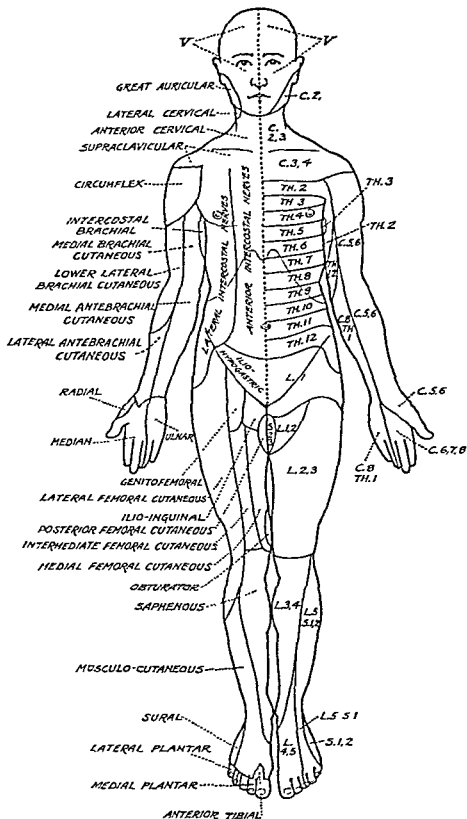


FIG. 24A. THE AREAS OF SKIN SUPPLIED BY THE SPINAL NERVES ARE SHOWN IN THE LEFT HALF OF THE FIGURE, AND THE SKIN AREAS SUPPLIED BY THE PERIPHERAL NERVES ARE INDICATED IN THE RIGHT HALF OF THE FIGURE. (After Cunningham.)

By this means information is obtained as regards the size and shape of the skull, the presence of bossing, the bony texture, the presence of fracture, the state of the sutures, the presence of erosion of the dorsum sellæ or clinoid processes, the vascular markings, the presence of abnormal or normal calcifications and the size of the optic foramina, etc.

Ventriculography (see p. 342).

Encephalography (see p. 342).

Angiography. For lateral views 10 ml. of 35% diodone are injected into the internal carotid artery, and X-ray films of the skull are taken during the injection, 2 seconds later and again 2 seconds later. For antero-posterior views 10 ml. of a 42% solution of diodone are used. This method assists in the diagnosis of aneurysms, cerebral hæmorrhage and cerebral tumours.

Electro-encephalography. Changes in electric potential arising in the cerebral cortex can be demonstrated with electrodes applied to the scalp. The normal electro-encephalogram shows characteristically

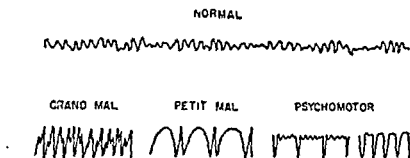


FIG 25. NORMAL ELECTRO-ENCEPHALOGRAM AND TYPES OF WAVES IN EPILEPSY. LENNOX. *Jour. Amer. Med. Assoc.*

small alpha waves. With a cerebral tumour or abscess and in epilepsy abnormal waves may be seen (see Fig. 25 and pp. 334, 352).

MENINGITIS

Definition. Inflammation of the meninges.

Varieties. 1. *Pachymeningitis* is inflammation of the dura mater. This is often secondary to disease or injury of the bone, such as spinal caries or a fractured skull. Hæmorrhagic pachymeningitis is met with in general paralysis of the insane. In chronic alcoholism and senile dementia it probably results from slight injuries to the skull not noticed by the patient. Pachymeningitis cervicalis hypertrophica may be due to syphilis and less frequently to tuberculosis.

2. *Leptomeningitis* implies inflammation of the pia-arachnoid. There is often also ependymitis or inflammation of the lining membrane of the cerebral ventricles. Leptomeningitis is usually due to invasion of the cerebrospinal fluid by micro-organisms, such as the *Mycobacterium tuberculosis*, the *Neisseria meningitidis* (meningococcus), the *Streptococcus pneumoniae* (pneumococcus), the streptococcus, the staphylococcus, the *Neisseria gonorrhoea* (gonococcus), the *Salmonella typhi*, the *E. coli*, the *Treponema pallidum*, and less often the *Hæmophilus influenzae*. Leptospiiral meningitis is due either to the *Leptospira icterohæmorrhagica*

C7. Triceps. Extensors of wrist and fingers. **C8.** Flexors of wrist and fingers. **Th. 1.** Intrinsic muscles of the hand. **Th. 2-10.** Intercostals. **Th. 7-12.** Abdominal wall muscles. **L 1.** Quadratus lumborum. **L 3.** Adductors of thigh. Psoas major and minor. Iliacus. **L 4.** Extensors of knee and abductors of thigh. **L 5.** Flexors of knee. **S 1.** Glutei and calf muscles. **S 2.** Anterior tibial muscles. Peronei. Intrinsic muscles of foot. **S 3 and 4.** Pelvic muscles. The cutaneous peripheral nerve and nerve root areas are illustrated in Fig. 24.

Co-ordination. (a) Upper limbs. This is tested by the ability to pick up small objects, and to touch the tip of the nose, with the eyes shut.

(b) Lower limbs. Romberg's sign. The patient cannot stand with the feet together and eyes closed. Co-ordination is tested also by asking the patient while lying down to touch with his toe an object held near it, or to touch his knee with the opposite heel.

(c) Past-pointing. This test is described on p. 405.

Trophic Changes. *Skin, e.g.,* glossy skin, perforating ulcers, painless whitlows, herpes zoster, bed sores, leucoderma, and increased sweating. *Bones and joints, e.g.,* facial hemiatrophy or hemihypertrophy, inequality of the two halves of the body, arthropathies.

The Gait. Spastic, ataxic, cerebellar, scissors, high stepping, reeling, festinating, hysterical, etc.

The Electrical Reactions. The stimulus is applied at the motor point where the nerve enters the muscle. Normally muscle directly stimulated responds to the make and break of a galvanic current, but not to a faradic stimulation. If the muscle is stimulated through the nerve at the motor point, it normally responds to faradisation and also to the make and break of the galvanic current.

Reaction of Degeneration. The muscle, when stimulated at the motor point, does not respond to faradic stimulation owing to nerve degeneration, and the response to galvanism is modified so that it is sluggish, or the anodal closure contraction is greater than the kathodal closure contraction, *i.e.,* A.C.C. > K.C.C. Normally the reverse is the case.

Electromyography. This affords more accurate information concerning the state of the peripheral nerves and the voluntary muscles than is given by the reaction of degeneration. Needle electrodes are inserted in the muscle, and changes in electric potentials during contraction are amplified by valves and recorded by a cathode ray oscillograph.

Lumbar Puncture. Normal cerebrospinal fluid: Pressure 150 mm. H₂O. Cells 1 to 5 mononuclears per cmm. Protein 20 to 40 mg., urea and non-protein nitrogen 15 to 30 mg., chlorides 700 to 750 mg., sugar 70 to 100 mg. per 100 ml. Lange curve 00000000000.

Myelography. By injecting a radio-opaque substance such as ethyl iodophenylundecalate (Pantopaque) into the cisterna cerebello-medullaris or into the spinal subarachnoid space by lumbar puncture the site of the spinal medulla (cord) obstruction can be visualised by X-ray examinations.

In the diagnosis and localisation of intracranial tumours certain other investigations may be required. These include:—

Radiography. The skull must be X-rayed from several angles.

similarly extension of the shoulder with the elbow extended may cause pain (Bikele's sign). Flexion of the neck causes flexion of one or both hips and knees (Brudzinski's sign). The temperature is raised to 101° or 103° F. (38.3° or 39.4° C.), and the pulse is frequent, such as 100 to 120. The abdomen is rather scaphoid, the bowels are constipated and vomiting occurs apart from taking food (cerebral vomiting). The deep reflexes are usually exaggerated. This is the *stage of irritation*.

A few days later a *stage of compression* may be reached. The patient is now definitely drowsy or comatose, but localised or general muscular convulsions may be seen, with irregular facial contractions. There is more marked head retraction but the back is rarely arched. The pupils are dilated and often unequal, and the patient may complain of difficulty in reading. In infants the anterior fontanelle may bulge. Optic neuritis and less often choroidal tubercles may be found on ophthalmoscopic

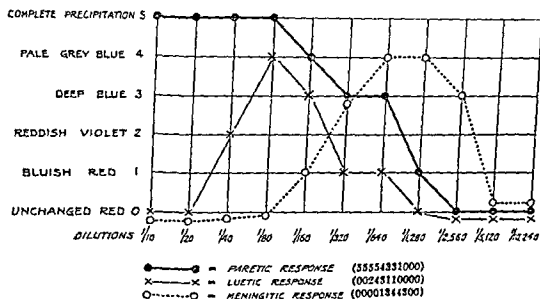


FIG. 26. LANGE COLLOIDAL GOLD CURVES.

Examination. The pulse is slower and premature systoles may be noted, the temperature is often lower, about 99° F. (37.2° C.), in the evening. Vomiting usually ceases during this stage. Later still, a *paralytic stage* may be reached, with incontinence of faeces and urine and a low temperature. Vomiting may now recur. The pulse tends to be more frequent and is often very rapid shortly before the end. Just before death the temperature may rise to 106° F. (41° C.) or higher. The pupils are dilated and do not react to light. The anterior fontanelle now becomes flat. The child lies on his back with the legs extended. The abdominal and deep reflexes are abolished. In many cases it is not possible to differentiate these stages. The Mantoux reaction is positive in about 85% of cases. The cerebrospinal fluid: The fluid is under pressure, clear or slightly turbid. On standing a fine coagulum often forms. Tubercle bacilli may be found in the majority of cases in the coagulum. Lymphocytes are present in excess, up to 400 or more per c.mm. In the early stages, however, 50 or 60% of the cells may be

or to the *L. canicola*. Aseptic meningitis and serous meningitis are also described.

8. *Arachnoiditis* is inflammation of the layers of the arachnoid, with cyst formation.

Tuberculous Meningitis

(Basilar Meningitis)

Etiology. The disease is caused by the *Mycobacterium tuberculosis*, 75% being of the human and 25% of the bovine type. *Predisposing causes* : 1. Age. Usually children between the ages of 1 and 6. Adults may be affected. 2. Sex. Equal incidence.

Pathology. Tuberculous meningitis is usually secondary to a tuberculous focus in the brain. The organisms are frequently carried to the brain by the blood stream from a tuberculous lymph node in the chest or abdomen. In some cases the brain lesions are secondary to tuberculous foci in the lungs, bones, joints, skin or genito-urinary organs. The development of meningitis is thus a fortuitous event, and does not depend on the existence of miliary tuberculosis. An operation on a tuberculous joint may cause a generalisation of the tuberculous infection with resultant meningitis. In adults tuberculous meningitis is usually a terminal event in cases of pulmonary or genito-urinary tuberculosis. At autopsy there is inflammation of the pia at the base of the brain, especially in the interpeduncular fossa, in the lateral sulcus (Sylvian fissure), and on the optic chiasma. Minute tubercles may be seen on the pia or on the branches of the middle cerebral, anterior and posterior perforating arteries. The cerebral gyri are somewhat flattened, the brain substance softened, and the ventricles contain an excess of cerebrospinal fluid producing a moderate degree of hydrocephalus. Minute tubercles may be found in other parts of the body, such as the lungs, liver and spleen, if a condition of miliary tuberculosis exists.

Clinical Findings. The patient is often a child of about 3 years of age. In some cases there is a history of a blow on the head some weeks previously or of a recent attack of measles or of whooping-cough. In other instances the child has been infected by a person in the home suffering from pulmonary tuberculosis, whose sputum contains tubercle bacilli. Often the patient has been apparently in good health, but for a few weeks previously has become listless and irritable, with headache, loss of appetite, slight temperature and loss of weight. The first symptom noted may be a convulsion.

On Examination : In the early stages the patient is usually rather irritable, restless and does not like being examined, drawing up the bed-clothes over himself (Stocker's sign). He may cry out from time to time ("hydrocephalic cry") and is easily startled by noises. He lies on his side with the knees drawn up. Twitching of various muscles may be seen and there may be photophobia. The only signs of an organic lesion which may be found are strabismus, due usually to weakness of the lateral rectus muscle, ptosis and some rigidity of the neck and back muscles. The pupils are rather small and the child may grind his teeth. Flexion of the hip with the knee extended is resisted (Kernig's sign) and

diet should be fluid, such as milk, or milk and tea, beef tea and barley water. Custards and jellies may also be given. If the patient cannot swallow he should be fed through a nasal catheter.

Meningococcal Meningitis

(including *Posterior Basic Meningitis of Infants*. *Cerebrospinal Fever*. *Spotted Fever*)

Etiology. The disease is due to the *Neisseria meningitidis* (meningococcus) of which there are four serological types, Group I (types I and III) and Group II (types II and IV). *Predisposing causes:* 1. Age: Infants, young children and young adults. 2. Sex: Incidence equal, but males predominate in war-time. 3. Season: Winter and spring. 4. Lack of ventilation and overcrowding at night. 5. Fatigue. 6. Naso-pharyngeal catarrh. 7. Climate: World-wide distribution. Sporadic cases and epidemics occur. Infection is spread by "droplets" from carriers, rarely from patients. Carriers are usually temporary ones for periods up to 3 weeks, chronic carriers are rare.

Pathology. The meningococcus probably spreads from the nasopharynx by the blood stream to the brain and spinal medulla (cord). Petechial hæmorrhages occur in the brain and spinal medulla (cord), and it is suggested that organisms present in these hæmorrhages pass into the cerebrospinal fluid. The pia-arachnoid at the base of the brain is inflamed around the pons, medulla oblongata and under-surface of the cerebellum. An exudate occurs between these membranes. The meninges covering the vertex of the brain and the cord are inflamed and encephalitis is present. The lateral ventricles may be dilated, giving rise to hydrocephalus. Purulent exudate may be present around the spinal medulla (cord), chiefly on the posterior aspect in the lumbar region. The mesenteric lymph nodes and intestinal lymphoid tissue are often swollen and the sphenoidal sinus may contain pus. Adrenal hæmorrhage occurs in some fulminating cases and encephalitis in others.

Incubation Period. 1 to 8 days.

Clinical Findings. The disease usually begins suddenly with a rigor, severe headache (occipital), vomiting and, in young children, convulsions.

Early or Septicæmic Stage: This usually lasts about 48 hours, but it may be considerably shorter. The temperature rises rapidly to 102° or 103° F. (38.9° or 39.4° C.). There is pain in the head, back and legs. Petechial or purpuric rashes may be seen, usually on the trunk or lateral sides of the thighs, about the second or third day of the disease. A blotchy erythema may also be noted, chiefly on the extremities. Painful symmetrical arthritis may affect various joints, usually without effusion.

Meningeal Stage: This usually rapidly ensues. There is stiffness in the neck, passing on to rigidity with some degree of head retraction, the patient lying on his side with hips and knees flexed. He is apathetic, the face somewhat flushed, the pupils are usually equal and dilated, reacting sluggishly to light. The vomiting persists and the headache becomes very severe, occurring in paroxysms which cause him to scream

polymorphonuclears. There is an excess of protein and the Nonne-Apelt test for globulin is positive. Sugar is diminished to 15 or 20 mg. per 100 ml. and the chlorides are reduced to 500 or 550 mg. per 100 ml. The Lange test shows a meningitic curve (see Fig. 26). The blood: A leucocytosis of about 12,000 per c.mm. may be present.

Differential Diagnosis. In the early stages the illness may be mistaken for influenza, or gastritis. Thus headache, vomiting, drowsiness, fever, and convulsions may all occur in gastro-enteritis. Apical pneumonia in a child may at the onset closely simulate meningitis. In meningism there are symptoms and signs of meningitis, although the results of lumbar puncture show no abnormality. The prolonged fever may suggest typhoid fever. The nervous symptoms may be confused with polioencephalitis or with encephalitis lethargica. A cerebral tumour or abscess may be mistaken for tuberculous meningitis, but in the former, optic neuritis is usually severe and cranial nerve palsies are not so apparent. If the patient is comatose, other causes of coma, such as diabetes mellitus and uræmia, must be excluded. The diagnosis of meningitis is established by the results of lumbar puncture, which also differentiate other varieties of meningitis. In tuberculous meningitis a fall in the sugar in the cerebrospinal fluid, below 45 mg. per 100 ml., is an earlier sign than is a fall in the chlorides.

Course and Complications. Tuberculous meningitis is usually rapidly progressive unless adequately treated, but a temporary remission with return of consciousness may occur in some cases.

Prognosis. Before the introduction of streptomycin the disease was almost invariably fatal, death occurring in 1 to 3 weeks. Some cases were more chronic, the patient surviving for 2 or 3 months. With streptomycin and isoniazid the prognosis is better, about 90% of patients recovering if treated early. If the patient is comatose, if choroidal tubercles are present, if the X-ray film of the lungs shows a snow-storm appearance, or if there is spinal or tentorial block, the outlook is usually hopeless. Some permanent cerebral sequelæ may occur in children.

Treatment. The patient should be on a water-bed. Treatment must be prolonged for at least a year. The tendency now is not to give streptomycin into the spinal subarachnoid space. It should be injected intramuscularly in doses of 0.5 G. daily for a child under 3 years and 1 G. daily for a child over 3 years. For an adult the dose is 1 G. b.i.d. For a child the dose should be continued for 1 to 3 months, it is then reduced to 1 G. twice a week for 6 months after the cell count and glucose content of the cerebrospinal fluid are normal. For an adult the dose is lowered after 6 months to 1 G. twice a week for 6 months. If vertigo or impairment of hearing occurs the dose must be reduced by 50%.

Isoniazid must be given simultaneously by mouth, the dose being 8 to 10 mg./kg. body weight for a child or adult, divided into two doses at 12-hour intervals for 6 weeks. The dose is then halved and given twice daily for 12 to 18 months. Sedatives such as pot. brom. 5 to 10 gr. (0.3 to 0.6 G.) t.d.s. for a child of 2 years should be given by mouth, and injections of morphin. sulph. $\frac{1}{4}$ gr. (7.5 mg.) may be required. The

known as the Waterhouse-Friderichsen syndrome. The onset of the disease is sudden, with pallor, and cyanosis which may be heliotrope and resemble that of influenza. Cutaneous hæmorrhages, rapid, feeble pulse, low blood pressure, rapid and shallow breathing, are characteristic features. The low blood pressure indicates the adrenal involvement. 3. Mild or ambulatory: Characterised by short but severe occipital headache, slight pyrexia and perhaps labial herpes. 4. Posterior basic meningitis of infants: This may be epidemic or sporadic. The onset may be insidious, but is often sudden with convulsions and vomiting followed by head retraction, with opisthotonus. The disease soon passes into the chronic stage with wasting, hydrocephalus and blindness due to cortical lesions. The hands and feet may show the characteristic attitude of tetany. Lumbar puncture usually is "dry" owing to blocking of the median and lateral apertures in the roof of the fourth ventricle (foramina of Magendie and Luschka). Puncture of the ventricles shows turbid fluid containing meningococci. The disease is usually fatal, unless adequately treated, in 1 or 2 months, but recovery may occur, the child being often mentally deficient or blind.

Differential Diagnosis. Cerebrospinal fever must be diagnosed from other causes of convulsions in infants, such as rickets, gastro-intestinal disturbances, or the onset of the infectious fevers.

If there are no meningeal symptoms other causes of continuous temperature must be excluded, such as typhoid fever, influenza or pneumonia. The presence of a purpuric rash and arthritic symptoms may suggest purpura rheumatica, and a sudden onset with rash may be mistaken for typhus fever. When meningeal symptoms are present it must be diagnosed from meningism, other varieties of meningitis, polioencephalitis, encephalitis lethargica and cerebral tumour. Other causes of coma must also be excluded. Examination of the cerebrospinal fluid establishes the diagnosis.

Course and Complications. Recrudescence of symptoms during the febrile period which was formerly common, is now very rare if adequate treatment is given. Relapses after an apyrexial interval are rare.

Complications include blindness, which may be central or due to suppuration in the eye, nerve deafness and hydrocephalus, hemiplegia, monoplegia, paraplegia, spastic ataxia, bronchopneumonia and arthritis with or without effusion. Acute hæmorrhagic nephritis may be the initial symptom. Sequelæ include headaches, mental instability and pains in the back.

Prognosis. This has been much improved by chemotherapy, the mortality being about 5% or lower.

Treatment. Prophylactic. In an epidemic, especially amongst troops, the beds should be spaced out to at least 36 inches (90 cm.). Tents should not be overcrowded and adequate ventilation ensured. A single dose of 2 G. of sulphadiazine is said to rid carriers of infection in 24 hours.

Isolation Period. The patient should be isolated until he has recovered, and the swab from the naso-pharynx shows no meningococci.

Curative: The patient should be put to bed in a well-ventilated

with pain. The patient complains of hyperæsthesia of the skin to touch and cold, and also of photophobia.

The most important physical signs are the absence of the abdominal reflex, the presence of Kernig's sign (inability to extend fully the knee when the hip-joint is flexed at a right angle), neck rigidity, and Brudzinski's neck sign (passive flexion of the head results in flexion of the hips and knees). Brudzinski's identical contralateral reflex is less often obtained, when one leg is flexed passively the other follows suit. The deep reflexes vary and the plantar reflex may be absent or extensor. Cranial nerve palsy is rarely seen, but the nerves most likely to be affected are the VI, VIII, III and VII in this order of frequency. In infants there is often some bulging of the fontanelle. There may be delirium, and the headache may persist throughout. Increased drowsiness is generally accompanied by incontinence of urine and fæces. The temperature usually remains raised and is irregularly remittent. The pulse varies with the temperature and is not typically slow. Respirations are increased and often irregular. Herpes may appear on the lips or on other parts of the body. The spleen is sometimes palpable. Rapid wasting occurs in some cases during the first week of the disease, the subcutaneous tissues being markedly dehydrated.

The blood : There is a polymorphonuclear leucocytosis of 10,000 per c.mm. or over. The causative organism can frequently be isolated from the blood. **The urine :** This rarely shows proteinuria, but glycosuria may be present. **The cerebrospinal fluid :** This is usually clear for the first 24 hours and then becomes turbid and under increased pressure. It contains pus cells and meningococci (Gram negative intra- and extra-cellular diplococci). Glucose is usually absent, the chlorides are reduced and the protein is increased.

The patient may die within 24 hours or after a few days, or the acute stage may be followed about a week later by convalescence, the headache and rigidity passing off and the temperature falling to normal, or there may be a more prolonged chronic stage.

The Chronic Stage : The chief clinical features are marked wasting despite a good appetite, vomiting, rigidity, muscular twitchings, hydrocephalus, dementia, convulsions, strabismus, nerve deafness, ptosis and at times facial paralysis. There is often incontinence of urine and fæces. The cerebrospinal fluid at this stage may show the characteristics of Froin's syndrome, if spinal block develops above. The fluid obtained by lumbar puncture below the block is clear and faintly yellow (xanthochromia). Such a stage may last for 2 to 3 months and the patient may then die or gradually recover.

Varieties : 1. Chronic meningococcal septicæmia without meningitis : The chief clinical features are recurrent attacks of fever, rigors, and small crops of petechiæ especially on the lower parts of the legs, the dorsum of the feet, and the hands. The condition can be diagnosed by blood culture or by finding meningococci in the petechiæ. 2. Fulminating : Death may occur in a few hours or days, the mind remaining clear in the adrenal type, and the patient being stuporose and later comatose in the encephalitic type. Cases with hæmorrhage into the adrenal are

premature systoles. There is irritability and rigidity of the neck and back muscles. There may also be strabismus and unequal pupils. The patient is often delirious and rigors may occur. The blood: There is a leucocytosis of about 12,000 to 20,000 per c.mm. The cerebrospinal fluid: This is turbid and under increased tension. There is an excess of leucocytes and the causative organism is present. The protein is increased, and the sugar content is low.

Differential Diagnosis. The presence of meningitis and its type is determined by the results of lumbar puncture.

Course and Complications. The disease is rapidly progressive.

Prognosis. Septic meningitis was almost always fatal but the prognosis has been much improved by chemotherapy and antibiotics.

Treatment. The general treatment is as described above for tuberculous and meningococcal meningitis. For streptococcal, staphylococcal and gonococcal meningitis sulphadiazine or sulphadimidine and penicillin should be given, as for meningococcal meningitis. The penicillin should first be given into the spinal subarachnoid space. Benzylpenicillin made up in pyrogen-free saline, 10,000 units (6 mg.) per 10 ml. is used. Ten ml. are injected after removing 10 ml. of cerebrospinal fluid. At the same time 1 million units (600 mg.) are injected intramuscularly and repeated every 8 hours. It is advisable to test the sensitivity of the organisms in the cerebrospinal fluid. Thus if staphylococci are found to be penicillin-resistant, cloxacillin (Orbenin) (see p. 157) may be the drug of choice. *H. Influenza*, coliform and *Streptococcus faecalis* infections are usually best treated with streptomycin, 50 to 100 mg. being injected into the spinal subarachnoid space daily, and 1 G. intramuscularly every 12 hours. The treatment should be continued for a week after the fluid has become clear. If streptomycin fails, sulphadiazine and penicillin should be given. Streptococcal meningitis is often associated with intracranial abscess, and ventricular puncture or ventriculography should be performed to exclude this as soon as the streptococci are found in the fluid.

Pneumococcal Meningitis

Etiology. The *Streptococcus pneumoniae* (pneumococcus) is the causative organism. A primary form is described in which the meninges are first affected, but meningitis is usually secondary to pneumonia, empyema or pericarditis, the organisms being carried in the blood stream. Direct spread may occur from a pneumococcal otitis media.

Clinical Findings. The clinical picture closely resembles that of septic meningitis (see p. 314). There is headache, vomiting, constipation, fever, neck rigidity and often convulsions, with a terminal stage of coma. The cerebrospinal fluid: This is turbid and under increased pressure. An excess of leucocytes is present, with pneumococci. The protein is increased, and the sugar content is reduced.

Differential Diagnosis. The diagnosis is established by the results of lumbar puncture.

Course and Complications. The disease is usually quickly progressive unless relieved by treatment.

room. The skin is tepid sponged twice a day and all pressure points protected by air rings. A water-bed may be necessary. Diet : Nasal feeding may be required, but the patient can usually swallow fluids. The bowels should be kept open daily with laxatives. Enemata may be necessary. The abdomen should always be examined to see if there is retention of urine and, if so, a catheter used. Drugs : For the headache, insomnia and pains, aspirin 5 to 10 gr. (0.3 to 0.6 G.) t.d.s. paraldehyde 120 to 240 m. (8 to 16 ml.), at night or an injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) or hyoscin. hydrobrom. $\frac{1}{160}$ gr. (3.0 mg.) may be necessary. Ice may be applied to the shaved head and hot baths used to ease the pain in the back.

Lumbar puncture relieves headache and tends to prevent hydrocephalus. It is required for 2 to 3 days in a few cases to relieve pressure symptoms. Frequently it is only necessary at the beginning and end of the treatment in order to establish the diagnosis and to ascertain that the fluid has returned to normal. Soluble sodium sulphadiazine is first injected intravenously. The dose is 0.05 to 0.1 G. of sodium sulphadiazine per kg. body weight. It is administered as a 0.5% solution in physiological saline, in order to achieve a blood concentration of 10 to 12 mg./100 ml. This is given for 2 days. Subsequently the same daily dose of sulphadiazine is given by mouth, divided into 4 doses administered every 6 hours for about a week. An adult should drink 4 to 5 pints (2.4 to 3 litres) of fluid every 24 hours and the urine should be kept alkaline with a potassium citrate mixture administered 3 or 4 times a day.

Benzympenicillin is not nearly as efficacious as the sulphonamides, and must be given in high dosage, 1 to 2 million units (600 to 1,200 mg.) intramuscularly every 2 hours for an adult, and half the dose for a child. Should symptoms of circulatory collapse be evident the treatment for an Addisonian crisis (see p. 716) is required.

Septic Meningitis

(Pyogenic or Suppurative Meningitis)

Etiology. Septic meningitis may be due to infection with the streptococcus, staphylococcus, the *Neisseria gonorrhæe* (gonococcus), the *Haemophilus influenzae* or coliform organisms such as the *Bacterium alkaligenes*. It may follow a direct spread of infection from otitis media, cranial sinusitis, mastoiditis or a cerebral abscess. In other cases it is secondary to septicæmia.

Pathology. A purulent infiltration of the meninges covers the vertex, and less often the base of the brain. The ventricles of the brain may be distended.

Clinical Findings. The symptoms and signs resemble those described above for other forms of meningitis, such as tuberculous or meningococcal. Thus there is headache, vomiting and usually constipation.

On Examination : The temperature is raised to 101° F. (38.3° C.) or higher, the pulse being about 90 or 100, and often irregular owing to

under increased pressure, clear or slightly turbid. There is an increase of cells, usually of lymphocytes. In some cases the polymorphonuclear cells are first increased, and later in the illness there is an excess of lymphocytes. The protein may be increased, but the sugar and chloride content are normal. No organisms are present, but in certain cases the virus can be isolated by animal inoculation during the first week of the meningitis, the result not being available, however, for 2 to 3 weeks.

Differential Diagnosis. The diagnosis is established by the course of the disease, the examination of the cerebrospinal fluid and agglutination tests on the serum. The Paul-Bunnell test is of value in the diagnosis of glandular fever. It is very liable to be mistaken for tuberculous meningitis until the cerebrospinal fluid has been examined. Leptospirocal meningitis may closely resemble clinically acute aseptic meningitis. In the former there is often ciliary congestion, and the diagnosis is confirmed by the agglutination test.

Course and Complications. The disease is of short duration, and there are no complications.

Prognosis. The patient usually recovers in about 7 to 10 days.

Treatment. No special treatment is required beyond a lumbar puncture to establish the diagnosis or relieve tension.

Meningism

This is a condition in which there are signs and symptoms of meningeal irritation, but the cerebrospinal fluid is normal and is not under increased tension. It is probably due to the presence of toxins in the cerebrospinal fluid. It may occur in apical pneumonia, especially in children, or in acute infections.

Arachnoiditis

(*Meningitis Serosa Circumscripta*)

Arachnoiditis may result from trauma or infection, it may be associated with diseases such as multiple sclerosis, tabes dorsalis, syringomyelia, and cerebral tumours, or it may occur as a sequela of leptomeningitis. Cerebral arachnoiditis is often situated in the region of the cortex, the optic chiasma or in the posterior fossa. The symptoms and signs resemble those of cerebral tumour, as the arachnoiditis is characterised by cyst formation. Primary optic atrophy may result from chiasmal arachnoiditis. Otitic hydrocephalus occurring in association with middle ear infection is closely allied to arachnoiditis. It is suggested that infection of the transverse sinus leads to retrograde thrombosis of the superior sagittal sinus. Absorption of the cerebrospinal fluid through the arachnoid villi is thereby blocked and hydrocephalus results. Treatment consists in repeated lumbar puncture. Spinal arachnoiditis gives rise to root pains followed by varying degrees of paraplegia. At operation a gush of fluid escapes from the arachnoid cyst, the arachnoid itself showing very slight signs of inflammation.

Prognosis. The prognosis has been much improved by sulphonamide and penicillin treatment.

Treatment. Sulphadimidine and penicillin should be given. The initial dose of sulphonamide should be high and the subsequent doses sufficient to maintain a concentration of 10 to 15 mg. per 100 ml. in the cerebrospinal fluid. Very young infants are given 1 to 3 G., and older children and adults 6 to 12 G. by mouth, as an initial dose. This is followed by a quarter of the initial dose every six hours until the patient seems entirely well clinically. This dose should not be reduced until the temperature has been normal for a week, and half the amount is then given for several days until two successive cultures of the cerebrospinal fluid are sterile. Penicillin should be given as follows:—10,000 units (6 mg.) of benzylpenicillin dissolved in 10 ml. of pyrogen-free saline are injected into the spinal subarachnoid space daily, after removal of 10 ml. of cerebrospinal fluid, for about 5 days, and 1 million units (600 mg.) of benzylpenicillin are given intramuscularly every 4 hours for 5 days.

If the cerebrospinal pathways become blocked by fibrino-purulent material, as shown by spinal block on lumbar puncture, 5,000 to 10,000 units of penicillin should be injected into the lateral ventricles, through burr holes in the skull daily for 4 to 7 days. Sulphadimidine should also be given by mouth or nasal tube, 4 G. followed by 2 G. every 4 hours for 5 days.

Acute Lymphocytic Chorio-Meningitis

(*Acute Aseptic Meningitis. Acute Serous Meningitis. Acute Benign Lymphocytic Meningitis. Virus Meningitis*)

Definition. A meningitis of acute onset with a favourable course, in which the cerebrospinal fluid is sterile.

Etiology. The disease is caused by a virus. Coxsackie A 9 and B viruses and types of ECHO virus have been found in the cerebrospinal fluid, throat swabs and faeces. The disease may be transmitted by mice. The virus has also been found in the spleen of dogs. A monocytic meningitis may occasionally occur in glandular fever, infectious jaundice and mumps. Acute idiopathic benign serous meningitis may complicate otitis media, cerebral abscess, chronic alcoholism ("wet brain"), or encephalitis lethargica.

Clinical Findings. The patient may be a child or adult. He is suddenly taken ill with headache (usually occipital), vomiting, stiffness of the neck, pains in the neck and limbs, and insomnia. The mind remains clear. Lymphocytic chorio-meningitis often has an influenza-like onset, the meningeal symptoms not appearing for 2 to 3 weeks.

On Examination: There is some rigidity of the neck and back, and Kernig's and Brudzinski's signs are present. There may be nystagmus and a squint. The temperature is raised to about 100° or 101° F. (37.8° or 38.3° C.), and the pulse is about 80 to 90. Ophthalmoscopic examination often reveals swelling of the disc (papilloedema). At times a transient facial palsy may be observed. The cerebrospinal fluid: This is

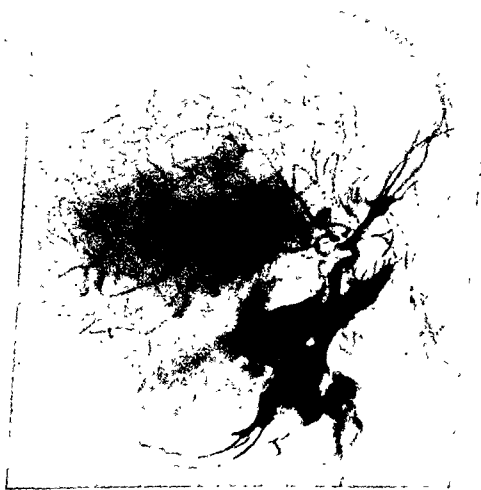


FIG. 27. CEREBRAL ARTERIOGRAM SHOWING ANEURYSM OF THE ANTERIOR COMMUNICATING ARTERY.

THE CEREBRUM

Intracranial Aneurysms

Pathology. The following varieties are described and the order of frequency of their occurrence is : 1. *Congenital*. These are thought to be due to weak spots in the muscle coat and are met with especially on the base of the brain at the junction of the anterior cerebral and anterior communicating arteries. They are said to resemble a berry hanging from a stalk. From the clinical standpoint these are of the greatest importance. 2. *Arteriosclerotic*. Degeneration occurs in the media. 3. *Infective, embolic or mycotic*. These result from adhesion of an infected embolus to the intima, and may occur in bacterial endocarditis or septicæmia. There is a tendency to rapid formation and rupture. Mycotic aneurysms are often found on the middle cerebral artery and occur chiefly in young people. 4. *Acute polyarteritis nodosa*. This is another cause, the outer coat of the artery being first involved. 5. *Syphilitic*. The basilar artery is chiefly affected. Some authorities state that this kind of aneurysm does not occur. 6. *Traumatic*. This is usually of the arterio-venous type, and situated between the internal carotid artery and the cavernous sinus.

The aneurysms vary in size from that of a pin's head to a fist, the average size being that of a pea. They are usually situated near the base of the brain but may be deep in a hemisphere. The middle cerebral and the basilar arteries are those most commonly affected. Rupture occurs in about 50% of all cases.

Clinical Findings. *Before rupture.* There are often no signs or symptoms before rupture occurs, but in some cases there is headache, usually homolateral, irritability, giddiness, tinnitus and nausea. Papilloedema may be present, and a localised systolic murmur is sometimes heard on listening to the skull over the aneurysm, especially in the arterio-venous type. Variability of signs from time to time is a feature of unruptured intracranial aneurysms. *Other localising signs* may be present which vary with the artery affected : *Internal carotid*. This results in pressure on the III, IV and VI and upper division of V nerves, with partial or complete internal and external ophthalmoplegia and pain or sensory loss over the forehead and eye. Pressure further forward on the optic path may result in hemianopia and optic atrophy. Non-pulsating exophthalmos may also occur. *Middle cerebral*. There may be Jacksonian fits and hemiplegia or monoplegia. *Anterior cerebral and anterior communicating*. (See Fig. 27). The signs may resemble those of a frontal lobe tumour. *Vertebral*. The syndrome produced may resemble that of thrombosis of the posterior inferior cerebellar artery. *Basilar*. The III, V, VI, VII or VIII nerves may be affected, or there may be pressure on the pituitary. *Arterio-venous aneurysm* of the internal carotid artery and cavernous sinus. This is a cause of pulsating exophthalmos.

At rupture. When rupture occurs the symptoms are usually those of subarachnoid hæmorrhage, but at times the hæmorrhage is intracerebral.

Differential Diagnosis. Intracranial aneurysms should be thought

of when there are symptoms of a cerebral tumour or of involvement of the III, IV, V and VI nerves. When rupture occurs and blood is found in the cerebrospinal fluid other causes of cerebral hæmorrhage have to be considered, such as hæmorrhage into a glioma. The skull should be X-rayed, for in some instances the calcified aneurysm is revealed. The shadow may be as large as a walnut. Albl describes an almost closed circle shadow, but only a portion of the arc, or several arcs of circles may be shown. Arteriography will usually reveal the exact site of the aneurysm.

Prognosis. Death occurs in about 60% of the cases which bleed.

Treatment. When facilities are available arteriography should be performed as soon as possible to locate the site of the aneurysm. It must then be decided whether an attempt should be made to deal surgically with the aneurysm, or to ligate the carotid artery on the affected side. Rest in bed is essential, and in some cases a sleepy state may be induced for periods up to 2 months by the administration of hypnotics such as phenobarbitone in adequate doses. Thus phenobarbitone 1 gr. (60 mg.) t.d.s. may be required. Lumbar puncture may be advisable (see Subarachnoid hæmorrhage, p. 322). If the blood Wassermann reaction is positive, anti-syphilitic treatment should be given (see p. 600).

Intracranial Hæmorrhage

Definition. Hæmorrhage into the brain or meningeal spaces.

Anatomy. Blood is brought to the brain by the two vertebral and the two internal carotid arteries. The vertebral arteries pass along the ventral surface of the medulla oblongata, and unite at the lower

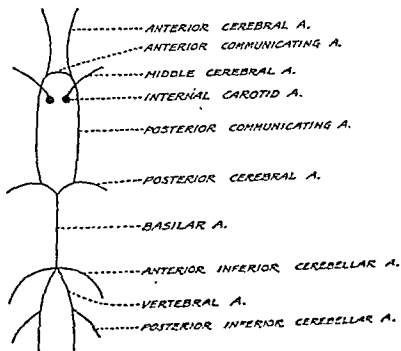


FIG. 23. DIAGRAM OF THE CIRCULUS ARTERIOSUS (OF WILLIS).

patient may then be unaware of the accident, or he may remember the accident and what happened for a short time after it. He may now pass into an automatic state during which he performs actions of which he has no subsequent recollection. The boxer who fights while "punch-drunk" affords an example of automatism. After a severe injury the patient immediately loses consciousness, and days or even months may elapse before it is fully restored. Certain stages are described in the process of recovery. These may overlap, and all may not be present. The initial coma and flaccid paralysis are followed by restlessness and stupor, which persist for a few days. This may pass into a stage of excitement, bewilderment and delirium in which the patient cannot feed himself, and is incontinent. This stage may last for several weeks or months, and may be interrupted by short periods of stupor. About this time the patient can usually talk more rationally and answer questions. The characteristics of this traumatic psychosis are a disorientation in time and space, retrograde amnesia, speech disturbances, confabulation and perseveration. Later there is a marked defect of memory for recent events (Korsakow's psychosis). Traumatic hysteria is very liable to follow head injuries. Residues which may persist for some time include headache, difficulty in concentration, abnormal fatigability, forgetfulness and intolerance of even small amounts of alcohol.

Acute Subdural Hæmatoma

Etiology. This results from the rupture of veins running across the subdural space, perhaps from the result of a slight blow on the head.

Clinical Findings. The symptoms occur within a few hours of the injury. Sudden attacks of coma with evidence of upper motor neurone lesions, followed by equally sudden return to consciousness and disappearance of physical signs, are very suggestive. Death is likely to occur unless a bilateral subtemporal trephining is performed.

Chronic Subdural Hæmatoma

Etiology. The most common cause is trauma, and it may result from birth injury. Less often it results from purpura, scurvy, carcinoma of the dura, neurosyphilis or chronic alcoholism.

Clinical Findings. After a latent period of a few weeks or months following a blow the patient complains of intermittent headache and mental dulness, gradually increasing in severity. Later, cerebral irritation may ensue, with convulsions or hemiparesis. Papilloedema is not constantly present. The cerebrospinal fluid may be under increased pressure and contain blood. The combination of signs of increased intracranial pressure, with a normal pressure of cerebrospinal fluid, is very suggestive of a subdural hæmatoma. The hæmatoma is often situated in the parietal region, and may be bilateral. Localisation is aided by arteriography.

In infancy it may cause mental retardation, bulging of the anterior fontanelle, spastic paraplegia, ocular palsies and retinal hæmorrhages.

border of the pons to form the basilar artery. At the upper border of the pons the basilar artery divides into the two posterior cerebral arteries. These are connected with the anterior cerebral arteries by the posterior communicating arteries, and in this way there is formed the *circulus arteriosus* (of Willis), lying in the interpeduncular space on the base of the brain. The internal carotid arteries give off the anterior cerebral arteries, and are then continued as the middle cerebral arteries. The anterior cerebral arteries are connected by the *anterior communicating artery* (see Fig. 28). The anterior cerebral artery supplies the frontal and parietal gyri. The middle cerebral artery supplies the motor and sensory areas of the cerebral cortex, including the speech area. The posterior cerebral artery is distributed to the ventro-medial portions of the temporal and occipital lobes. Central branches enter the brain substance from the anterior, middle and posterior cerebral arteries, and from the *circulus arteriosus* (of Willis). The medial and lateral striate branches of the middle cerebral artery are distributed to the external capsule, the lentiform nucleus, the anterior part of the internal capsule and the caudate nucleus. One, larger than the others, is a frequent site for a cerebral hæmorrhage. The anatomy of the cranial venous sinuses is given on p. 331.

The chief types of intracranial hæmorrhage will now be described.

Extradural or Epidural Hæmorrhage

Etiology. This is associated with concussion and injury to the skull and is also met with in hæmorrhagic pachymeningitis. It is most often due to a tear in the middle meningeal artery caused by fracture of the skull.

Clinical Findings. At the onset the patient is generally unconscious, and convulsions may occur according to the part of the brain stimulated by the hæmorrhage. He may then recover consciousness for a few hours and appear much better. Recovery may then take place, often associated with a *post-concussional state*, or this "*lucid interval*" may be followed by coma and death.

Treatment. X-ray of the skull, arteriography and electro-encephalography are all of value in localising the site of the bleeding. When the hæmorrhage is due to trauma and there is evidence that the bleeding is continuing, the skull should be trephined and an endeavour made to ligature the bleeding vessel and evacuate the clot.

Concussion and the Post-Concussional State

Pathology. The nature of the concussional cerebral changes due to head injuries remains obscure, despite much experimental investigation. Perivascular petechial hæmorrhages, resulting from diapedesis, may be found, usually in the cortex and often in the subjacent white matter and in the grey matter of the brain and brain stem.

Clinical Findings. After a minor injury the patient may be temporarily unconscious, exhibiting a flaccid paralysis. The pulse is feeble, temperature subnormal, respirations shallow and slow, and the pupils are dilated. Recovery of consciousness may be rapid or gradual. The

morphine. If there is pulmonary œdema, atropin. sulph. $\frac{1}{100}$ gr. (0.6 mg.) and morphin. sulph. $\frac{1}{2}$ gr. (20 mg.) should be injected subcutaneously. Methyldopa (Aldomet), 250 mg. tab. q.i.d., may be given to lower blood pressure. It may be possible to arrest the bleeding by operation, but surgical treatment during the phase of bleeding has a high mortality rate. If the patient survives the initial bleeding, an operation within eight weeks of the hæmorrhage should be considered.

Intracerebral Hæmorrhage

Definition. Hæmorrhage into the substance or ventricular system of the brain.

Etiology. Hæmorrhage results from rupture of a cerebral artery or aneurysm, or of capillaries, cortical cerebral veins or venous sinuses. Exciting causes include muscular strain and trauma to the skull. *Predisposing causes:* 1. Age: Usually over 40 years. In children hæmorrhage may occur from rupture of cortical veins in whooping-cough, there may be hæmorrhage into a glioma or rupture of an intracranial aneurysm; in infants, hæmorrhage may be due to birth injuries, or rupture of an intracranial aneurysm. 2. Sex: Males predominate. 3. Heredity: Cerebral hæmorrhage tends to run in families. 4. Arteriosclerosis, angiospasm, high blood pressure and chronic nephritis. 5. Blood diseases, such as leukæmia or purpura.

Pathology. The middle and lateral striate branches of the middle cerebral artery are most frequently affected, the lesion being situated commonly in the thalamus, internal capsule and corpus striatum. Spread to the ventricular system is frequent. In blood diseases, hæmorrhage may occur by diapedesis. Bleeding usually continues until the patient dies. Congenital aneurysms may leak from time to time before the fatal hæmorrhage occurs. Further an old blood cyst may be found in the brain at autopsy, which indicates the site of a previous hæmorrhage from which the patient has recovered. Meningeal hæmorrhage due to birth injury may lead to atrophy or to the formation of cysts in the brain (porencephaly). The pathology of intracranial aneurysms is considered on p. 318.

Clinical Findings. There may be a history of previous slight attacks or "little strokes" from which the patient has recovered to a varying degree. The onset is generally sudden, the patient falling unconscious with the apoplectic stroke. Less often there are prodromal symptoms, such as headache, giddiness, vomiting, disturbance of speech, or tingling and weakness in a limb. A stroke due to a cerebral hæmorrhage is not so common as one due to cerebral thrombosis. The results produced vary with the site of the lesion:

1. *Capsular Hæmorrhage.* This is the most common variety, the bleeding starting external to the internal capsule.

On Examination: The patient is unconscious, the face is usually flushed, cyanosed and sweating, rarely it is pale. The breathing is stertorous, and the cheek on the paralysed side may be blown in and out with respiration. There is no movement of the limbs, which are

Treatment. The clot should be removed surgically. It is usually advisable to explore both sides of the brain.

Subarachnoid Hæmorrhage

Etiology. Subarachnoid hæmorrhage is usually due to rupture of a congenital or mycotic cerebral aneurysm. Other causes include head injuries, effusion of blood from an intracerebral hæmorrhage, a leak from an angioma, hæmorrhagic encephalitis or blood diseases.

Clinical Findings. A congenital intracranial aneurysm usually causes no symptoms until it begins to leak. Slight degrees of bleeding may give rise to headache. In more severe cases the patient experiences intense headache, often first occipital and then frontal, he then vomits and rapidly loses consciousness.

On Examination : The patient is semi-conscious and looks very ill. The pulse is frequent, breathing stertorous, and the temperature may rise to 101° F. (38.3° C.) or higher. The abdominal reflexes and tendon reflexes are usually depressed or absent, and an extensor plantar response may be present on one or both sides. There may be a certain amount of neck rigidity or head retraction, and convulsive movements of the extremities. The pupils are dilated, and papilloedema, retinal or subhyaloid hæmorrhages, the latter being situated between the vitreous and the retina, may be seen on ophthalmoscopic examination. The urine may contain a considerable amount of protein for a few days. Glycosuria is present at times, with traces of acetone. Electrocardiographic changes resembling those of myocardial infarction may be found, and they also may occur in cerebral hæmorrhage. Usually there is no evidence of a cardiac lesion at autopsy, but occasionally subendothelial hæmorrhages have been found. If a lumbar puncture is performed, the fluid is found to be uniformly mixed with blood which does not clot on standing. Xanthochromia is present after 24 hours. Red cells disappear from the fluid about 7 days after the hæmorrhage has ceased. The bleeding may stop and the patient recover, having various sequelæ, such as headache, disturbance of vision and of mentality, or certain paralyses. The III, V, VI or VII nerves may be pressed on, with partial III nerve palsy, intense pain on one side of the face, abducens palsy, or lower motor neurone facial palsy. In other cases the hæmorrhage continues, generalised bronchitis and œdema of the lungs develop, and the patient dies in the course of a day or so. *The anterior choroidal syndrome* may quickly follow a subarachnoid hæmorrhage. This is characterised by contralateral hemiplegia, hemianæsthesia and hemianopia. Localisation of the aneurysm may be effected by bilateral carotid arteriography, but in about 20% of cases it does not reveal the lesion.

Prognosis. About 60% of cases of subarachnoid hæmorrhage are fatal. Epileptic attacks ensue in some survivors.

Treatment. An initial lumbar puncture is advisable to establish the diagnosis, but it is usually wise not to repeat the lumbar puncture as a routine measure as this may cause the bleeding to recur. It should, however, be repeated if the coma deepens or the blood pressure rises, and if there are convulsions, or headache which is not relieved by

often lower than in hæmorrhage, and usually a cardiac lesion, such as mitral stenosis or atrial fibrillation, is present. Cerebral thrombo-phlebitis, secondary to systemic thrombosis elsewhere, may closely simulate cerebral embolus. The spread of infection is considered to be by mural thrombo-phlebitis, along the intravertebral veins. The lungs are not often affected and a mistaken diagnosis of paradoxical embolus (see p. 326) may be made. Other causes of coma include uræmia, diabetes mellitus, cerebrospinal meningitis, opium and alcohol. In some cases epilepsy and hysteria will require exclusion. In uræmia the urine contains protein and casts, and the percentage of urea in the blood and cerebrospinal fluid is generally raised. In diabetic coma the breath smells of acetone, and the urine contains sugar and acetone bodies. In cerebral hæmorrhage, although sugar may be present in the urine, acetone bodies are absent. In hypoglycæmic coma the patient may have convulsions, but a history of diabetes with insulin administration can be obtained, and consciousness is usually restored by the subcutaneous injection of 1 ml. of inject. adrenaline (B.P.) 1 in 1,000. Examination of the cerebrospinal fluid enables a diagnosis of cerebrospinal fever to be made. In opium poisoning the pupils are pin-point, and some evidence of the administration of the drug or its derivatives can usually be found. Alcohol poisoning may cause difficulty, as the patient may have a hæmorrhage while under the influence of alcohol, and so he should always be kept under observation for 24 hours. In epilepsy the unconscious and convulsive phases are generally of comparatively short duration, and if there is resultant hemiplegia (Todd's paralysis) recovery is complete. The nature of a hysterical attack is usually clear (see p. 370).

Course and Complications. It is doubtful if a patient can survive a cerebral hæmorrhage; in some cases, after an apparent improvement with recovery of consciousness, there is recurrence of coma followed by death due to spread of the bleeding into the lateral ventricle.

Prognosis. A cerebral hæmorrhage is often fatal in from 2 to 48 hours.

Treatment. The patient should be propped up in bed, all tight clothing loosened, dentures removed and an airway maintained by turning him slightly on one side or by using an anaesthetist's airway. If there is marked venous engorgement in the neck, and cyanosis, 10 fl. oz. (300 ml.) of blood should be removed from a vein and the bowels opened by an enema. A lumbar puncture is not without danger, as it may lead to compression of the medulla oblongata in the foramen magnum. If blood is present, the diagnosis of hæmorrhage is confirmed; if it is absent, stimulants, such as nikethamide (Coramine) 2 ml. should be administered subcutaneously six-hourly. If the patient survives, nasal feeding is often required for a time and penicillin should be given to prevent basal bronchial infection. Catheterisation may be necessary. In some cases it is possible to locate the site of the bleeding by arteriography, and to remove the clot. In a series of over 2,000 cases of primary intracerebral hæmorrhage the immediate operative mortality was 51%, and only 26% recovered after the operation. Of the survivors 42% were reported on as being well, but 10% were totally disabled.

flaccid. On lifting up an arm or leg, a greater degree of flaccidity may be detected on the paralysed side. In the early irritative stage there may be conjugate deviation of the eyes, which look away from the site of the lesion in the brain, later with a paralytic lesion the deviation is in the opposite direction towards the site of the lesion. The corneal, superficial and deep reflexes are lost. There may be incontinence or retention of urine, and incontinence of faeces. The pulse is full and bounding, and may be slow or rapid. The temperature is usually subnormal at the onset, and the blood pressure is raised. The urine often contains protein, and sugar may be present. The cerebrospinal fluid contains blood if the hæmorrhage has extended into the lateral ventricle. If the patient survives he will pass in a few days into a post-apoplectic stage, described on p. 326 under the title "chronic residual hemiplegia."

2. *Cortical Hæmorrhage.* This is rare. The patient does not generally lose consciousness. Convulsions or paralysis of one or more limbs, aphasia or hemianopia may develop according to the site of the lesion.

3. *Thalamic Hæmorrhage.* This will produce the thalamic syndrome (see p. 333).

4. *Mid-brain Hæmorrhage.* There may be paralysis of the III nerve, with hemiplegia on the opposite side (Weber's syndrome). There may also be anæsthesia of the paralysed side of the body.

5. *Pontine Hæmorrhage.* The patient rapidly becomes comatose. There may be convulsions of the legs, with vomiting, Cheyne-Stokes breathing, and pin-point pupils. Conjugate deviation of the eyes may also be noted, in a direction opposite to that characteristic of a supranuclear lesion (see p. 390). There may be contralateral hemiplegia. The pupils may dilate before death. The temperature rises to 106° F. (41° C.) or higher, and the patient dies within a few hours.

6. *Medullary Hæmorrhage.* The patient usually dies in coma within a few hours, before signs of bulbar paralysis are apparent.

7. *Ventricular Hæmorrhage.* This is usually secondary to capsular hæmorrhage causing rapid death. There may be head retraction, with rigidity or spasms of the arms or legs.

8. *Cerebellar Hæmorrhage.* (See p. 377.)

Differential Diagnosis. The clinical diagnosis of the cause of a stroke is extremely uncertain, but it has been improved by the use of radiological investigations. These include plain X-ray films of the skull, arteriography and pneumo-encephalography. The diagnosis includes a consideration of cerebral thrombosis, cerebral embolus, a hypertensive cerebral attack and other causes of coma. In cerebral thrombosis the onset is more insidious and more likely to occur at night. The patient may experience numbness or tingling in the limb, followed during the course of a few hours by paralysis. The cerebrospinal fluid does not contain blood. In cerebral embolus the onset is usually sudden, but often the patient does not lose consciousness unless an extensive area of brain is involved. There may be aphasia, monoplegia, hemiplegia, or supranuclear paralysis of the VII cranial nerve. The age incidence is

movements is obtained, the arm being always more paralysed than the leg. Thus there is power of extension of the hip and knee, and of plantar flexion of the ankle and toes. As regards the arm the patient is able to abduct and elevate it, and to flex the elbow, wrist and fingers. The muscles producing these movements become spastic and their deep reflexes are increased, due to the uncontrolled activity of the extra-pyramidal motor paths. Ankle-clonus and knee-clonus are frequently obtained, and the plantar response remains extensor. The abdominal reflex may return on the paralysed side. There are also certain "associated reactions," thus if the patient yawns he may extend his wrist and fingers and raise his hand in front of his face, performing movements involuntarily which he cannot achieve voluntarily.

Prognosis. This is always unfavourable in major strokes; in less severe attacks a considerable degree of recovery may occur. Recurrent thrombosis or a fatal cerebral hæmorrhage is liable to ensue. Whereas the number of deaths from cerebral hæmorrhage was about the same from 1945 to 1966, deaths from embolus and thrombosis were doubled in this period.

Treatment. The patient should be kept in bed at the onset, and stimulants administered, such as subcutaneous injections of nikethamide (Coramine) 2 ml. t.i.d. or of strychnin. hydrochlorid. 1/33 gr. (2 mg.) t.i.d. Anticoagulant treatment should be avoided if the diagnosis from cerebral hæmorrhage is uncertain. The Wassermann reaction should be determined, and if positive, benzylpenicillin should be injected intramuscularly, 1 million units (600 mg.) daily for 21 days. Splints should be applied to the affected arm to prevent flexion of the wrist and fingers, and the leg should be maintained rotated medially with the ankle dorsiflexed by means of sandbags. Gentle massage and passive movements should be given in the course of a few days. As soon as possible the patient should be encouraged to perform active movements, but electrical stimulation of the muscles is always contra-indicated. The patient should be sat in an arm chair as soon as he has recovered from the shock of the stroke.

Cerebral Embolus

Definition. Obstruction of a cerebral artery by an embolus.

Etiology. The embolus may be derived from the following sources:

1. A valve of the heart, especially the mitral and less frequently the aortic valve. This occurs in chronic endocarditis.
 2. The left atrium or ventricle, a portion of clot being detached in mitral stenosis, atrial fibrillation or flutter, or in coronary thrombosis.
 3. The endocardium, in acute or subacute bacterial endocarditis.
 4. The aorta, in aneurysm or atheroma.
 5. The right subclavian artery, from pressure of a cervical rib.
 6. The pulmonary veins, in suppuration of the lungs.
 7. The systemic veins, if there is a patent foramen ovale or patent ventricular septum (paradoxical embolism).
 8. Fat emboli, resulting from fracture of long bones, may pass through the lungs and lodge in the brain.
- Predisposing causes:** 1. Age: Adults and young people. 2. Sex: Females predominate.

Cerebral Thrombosis

Definition. Coagulation of blood in the cerebral vessels.

Etiology. *Predisposing causes:* Arteriosclerosis, syphilitic endarteritis, low blood pressure, chronic nephritis, slowing of the circulation in various debilitating conditions, polycythæmia rubra, anæmia, septicæmia, encephalitis lethargica, and polioencephalitis. Cerebral thrombosis may also result from trauma, such as a wound of the brain, or develop in the neighbourhood of a cerebral tumour, or be secondary to a cerebral embolus. *Adults over middle age are usually affected*, syphilis being the commonest cause in young adults.

Pathology. The middle cerebral artery is most frequently affected. The resultant infarct may be red or white. The central arteries are end-arteries, and so softening of the brain with degeneration of nerve elements usually results from their obstruction, and later a scar or cyst may form. The anastomoses are better developed for the cortical arteries.

Clinical Findings. If thrombosis affects a large artery the onset of symptoms is acute with coma. When smaller vessels are involved there are often prodromal symptoms. Thus the patient may complain for a few days of headache, giddiness, disturbance of speech, numbness or tingling of a hand or arm, with subsequent paralysis. In some cases there are convulsions at the onset.

On Examination: If a large vessel is blocked, the patient is comatose and the clinical findings resemble those described for cerebral hæmorrhage. The signs depend upon the site of the lesion. 1. *Middle cerebral artery thrombosis.* There is usually hemiplegia. At the onset the affected side of the body is flaccid and the superficial and deep reflexes are abolished. The lower half of the face is affected and also the tongue, so that on protrusion it deviates towards the paralysed side. The muscles of mastication, deglutition and the trunk muscles are not usually paralysed. There is some weakness in turning the head and eyes to the paralysed side. In a day or so the plantar response is extensor on the affected side, and the abdominal reflex is absent on the paralysed side, but present on the sound side. 2. *Anterior cerebral artery thrombosis.* There may be no symptoms, or dementia may ensue. The "grasp-reflex" (see p. 335) may be present in one or both feet. Contralateral crural monoplegia may rapidly develop. 3. *Posterior cerebral artery thrombosis.* There may be homonymous hemianopia, the patient having difficulty in avoiding objects on his blind side. Hemianæsthesia may also be present. 4. *Internal carotid thrombosis.* This causes coma and rapid death. 5. *Basilar artery thrombosis.* This produces symptoms resembling those described for pontine hæmorrhage. 6. *Vertebral artery thrombosis.* This may produce symptoms of acute bulbar paralysis.

Differential Diagnosis. This is as described for cerebral hæmorrhage (see p. 324).

Course and Complications. After the acute phase of hemiplegia has passed, in cases of middle cerebral artery thrombosis, the patient enters the stage of "chronic residual hemiplegia." Recovery of certain

on coat and waistcoat), changes in writing, transient weakness of a limb, etc. Anticoagulants should not be given. Spasmocycline may be helpful.

Vertebro-Basilar Insufficiency

This is characterised by attacks of giddiness, occipital headache, diplopia, transient blindness, ataxia, tingling round the lips and at times hemi- or tetraparesis. The patient may fall in an attack. There is usually nystagmus between the attacks. With cervical spondylosis and atheroma of the vertebral arteries rotation of the head may cause partial or complete occlusion of a vertebral artery. Vertebral arteriography is dangerous. Anticoagulants should not be used. An electroencephalogram may indicate temporal lobe disturbances. An operation on the carotid artery to remove obstruction due to atheroma may relieve the symptoms.

Brachial-Basilar Insufficiency

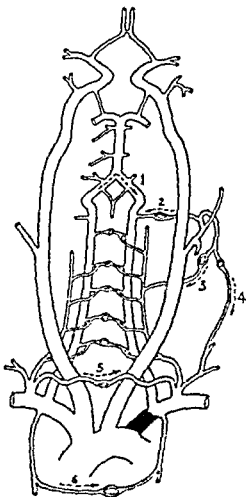
(The Subclavian Steal Syndrome)

Stenosis of a subclavian artery proximal to the origin of the vertebral artery results in diminished blood supply to the brain through the vertebral artery. It may also result in weakness of the hand when it is being

FIG. 29. SUBCLAVIAN STEAL SYNDROME.

Diagram of principal channels of collateral circulation in the presence of occlusion of the proximal segment of the subclavian artery: (1) Vertebro-vertebral, (2) external carotid (occipital)-vertebral (muscular), (3) external carotid-thyro-cervical (ascending cervical), (4) external carotid-costocervical (deep cervical), (5) between inferior thyroids, and (6) between internal mammary arteries.

(North, R. R., Fields, W. S., De Bakey, M. E., and Crawford, E. S., (1962) *Neurology* (Minneapolis) 12:810).



Pathology. The left middle cerebral artery is most often obstructed, the effects produced resembling those described for cerebral thrombosis.

Clinical Findings. The onset is sudden, and there are no prodromal symptoms. There may be convulsions, aphasia, monoplegia, hemiplegia, visual disturbances, or facial palsy of the upper neurone type, according to the part of the brain affected. Consciousness may or may not be lost, depending upon the extent of brain involved. Carotid hemiplegia is due to an embolus obstructing the internal carotid artery, there is homolateral blindness and heterolateral hemiplegia. In many cases an associated cardiac lesion is present, and in some instances the embolus forms during the administration of quinidine.

Differential Diagnosis. This is as described for cerebral hæmorrhage.

Course and Complications. In carotid hemiplegia there is often restoration of function due to establishment of a collateral circulation through the circulus arteriosus (of Willis). Recurrent emboli are liable to form. In the majority of cases the course of the lesion resembles that described for cerebral thrombosis.

Prognosis. There is usually recovery of the use of the leg in hemiplegia, but the hand and arm often remain permanently paralysed, and speech may be deranged, especially when the patient is excited. Death results if a large area of the brain is deprived of its blood supply.

Treatment. Nicotinic acid, 100 mg., or tolazoline hydrochlor. (Priscol) 50 mg., should be injected intravenously, to dilate the cerebral arteries with the hope that the embolus will pass to a smaller vessel. Apart from this, treatment is as described for cerebral thrombosis.

Extracranial Arterial Lesions

Affecting the Brain

Extracranial arterial disease, such as atheroma of the aorta, the common carotid and its branches, is the cause of embolus in some minor or less severe strokes. In major strokes there may be both extracranial and intracranial arterial disease. Non-embolic infarction is due either to a thrombus in a cerebral artery or to atheromatous stenosis of extracranial arteries. Hemiplegia in children may be due to inflammatory carotid arteritis in the neck, secondary to a throat infection.

Carotid arteriograms will demonstrate the presence of stenotic lesions, which in some cases may be dealt with surgically.

Cerebral Atrophy

This is liable to occur in elderly people due to atherosclerosis of intracranial arteries. There are loss of memory for recent events, periods of disorientation, insomnia, depression, slowing of movement, tremors, etc. Sparine (Promazine) 25 mg. tab., 1 to 2 daily, may be of value, or spasmocycline (Cyclospasmol) 100 mg. tab., one t.d.s.

Little Strokes

These are due to cerebral ischæmic attacks, characterised by dizziness, loss of ability, loss of interest in personal appearance (gravy spots

due to caries or a fracture, (d) in the orbit, nose or upper lip. Thus it may follow a boil, carbuncle or insect bite (cavernous sinus thrombosis). In other cases the infection spreads from the ear, mouth or throat. It may also be a manifestation of thrombo-phlebitis migrans or be secondary to peripheral systemic thrombosis which has spread to the brain along the intravertebral veins.

Anatomy and Pathology. The anatomy of the important cranial venous sinuses is indicated in the diagram (see Fig. 30). The walls of the sinuses consist of dura mater. The blood enters the sinuses from the brain and the meninges. The direction of flow in the emissary veins is uncertain. The blood passes from all the sinuses into the internal jugular veins. There are five single sinuses, namely, the superior sagittal, the inferior sagittal, the straight, the intercavernous, and the basilar venous plexus. There are six paired sinuses, namely, the transverse, the occipital, the cavernous, the superior petrosal, the inferior petrosal, and the sphenoparietal sinuses. From the medical

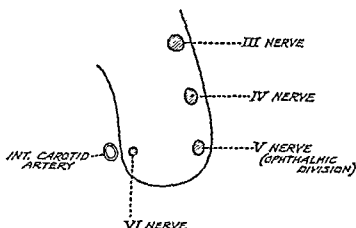


FIG. 31. DIAGRAM SHOWING THE CAVERNOUS SINUS AND ITS NERVES.

point of view the most important are the cavernous sinus, the transverse sinus and the superior sagittal sinus. The cavernous sinus is in close proximity to the sphenoidal air sinus, and only separated from it by a thin layer of bone. The internal carotid artery and the VI nerve are on its inner side, and the III, IV and V nerves pass through its outer wall (see Fig. 31). The ophthalmic veins enter it in front and it is also in communication anteriorly with the frontal and supraorbital veins. The superior and inferior petrosal sinuses connect it with the transverse sinus behind. The intercavernous sinus connects the two cavernous sinuses. The superior sagittal sinus receives blood from the brain, and obstruction is liable to cause gross cerebral disturbance. Infection probably spreads by means of infected blood clot or along the sheath of the I and VIII nerves. There is no lymphatic path. At autopsy a clot may be found adhering to the wall of the sinus, and in some cases it extends into the jugular and subclavian veins, or even into the superior vena cava. Organisms, such as streptococci or pneumococci, may be present in the clot.

actively used, accompanied by giddiness. The obstruction of the subclavian artery causes a drop in hydrostatic pressure at the level of the mouth of the vertebral artery, and the higher pressure in the basilar artery and in the opposite vertebral artery, causes the flow in the affected vertebral artery to be reversed. Compensatory channels of collateral circulation in the presence of occlusion of the proximal segment of the subclavian artery include the vertebro-vertebral; the external carotid (occipital)-vertebral (muscular); the external carotid-thyrocerical (ascending cervical); the external carotid-costocervical (deep cervical); between the inferior thyroids and between the internal mammary arteries (see Fig. 29). Blood may therefore enter the subclavian artery beyond the proximal obstruction.

Sinus Thrombosis

Definition. Coagulation of blood in the cranial venous sinuses.

Etiology. 1. *Primary sinus thrombosis.* This is an aseptic process. In infants it may be due to marasmus or to congenital syphilis, and in adults to anæmia and to wasting diseases such as tuberculosis, or carcinoma. The superior sagittal sinus is usually affected. 2. *Secondary sinus thrombosis.* This results from sepsis, as (a) in the middle ear (transverse sinus thrombosis), (b) in the paranasal sinuses, (c) in the skull

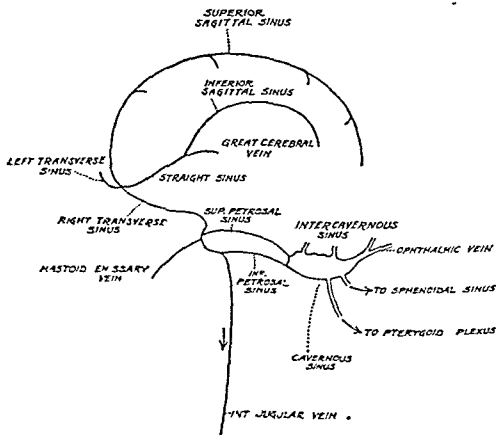


FIG. 30. DIAGRAM SHOWING THE CRANIAL VENOUS SINUSES.

indicate whether meningitis is present, but meningitis may also occur as a complication of the sinus thrombosis.

Course and Complications. The course is usually rapid, complications include meningitis, cerebral abscess and pyæmia.

Prognosis. This is very grave, but has been considerably improved by the use of penicillin.

Treatment. Prophylactic. Septic spots on the upper lip and nose should be fomented and not squeezed, and early surgical intervention is dangerous. When pus definitely forms it should be evacuated through a small incision. All cases of otorrhœa should be adequately treated.

Curative. Benzylpenicillin should be given, 60,000 units (36 mg.) intramuscularly every 3 hours for 7 to 10 days. In transverse sinus thrombosis it may be advisable to ligature the jugular vein to prevent spread of infection.

Intracranial Tumours

Definition. New growths, granulomata and cysts arising in the brain, meninges or interior of the skull.

Etiology. In some cases of intracranial tumour there is a history of a blow on the head, followed by the signs of the tumour. These signs may result from the occurrence of œdema or hæmorrhage in or around a pre-existent tumour. *Predisposing causes:* 1. Age. The majority of tumours occur in young or middle-aged people. Glioma and tuberculoma may affect children. 2. Sex. Males predominate slightly.

Pathology. The following tumours may occur, and they are grouped approximately in their order of frequency: Glioma (including astrocytoma, multiple spongioblastoma, medulloblastoma, ependymoma, etc), pituitary adenoma, meningioma (endothelioma), acoustic neuro-fibroma, congenital cysts, secondary malignant growths such as sarcoma, carcinoma and hypernephroma, gumma, tuberculoma, vascular tumours such as telangiectasis, venous angioma, arterio-venous aneurysm and angio-blastoma, papilloma, cholesteatoma, psammoma, fibroma, chloroma and lipoma. Primary sarcoma and actinomycosis are rare. In children a tuberculoma is not so frequently met with, as formerly. Cysts include a dermoid, hydatid, cysticercus cellulosa, serous cyst, blood cyst, colloid cyst of the third ventricle and congenital cysts. The glioma is ectodermal in origin, it tends to infiltrate the cerebral substance, is vascular and liable to hæmorrhage or to cystic degeneration. The meningioma arises from arachnoid connective tissue. It invades bone with secondary bony overgrowth, and compresses the brain. Carcinoma of the brain is usually secondary to a growth in the breast, lung or kidney. The increase in size of the tumour causes cerebral anæmia, and the anoxia thus produced may result in localised epileptiform fits. Increased intracranial tension and hydrocephalus are obstructive phenomena. The frontal region is the site of about 20% of brain tumours, and about 17% occur in the cerebellum.

Clinical Findings. The initial symptoms are usually insidious, but at times an intracranial emergency provokes an acute onset. Thus a

Clinical Findings. *Cavernous Sinus Thrombosis.* In a typical case the patient has noticed a sore place or small boil on the upper lip or the inside of the nose. It may have been opened surgically. A day or so later the patient complains of frontal headache with malaise and drowsiness. Later, there may be pain in the side of the face or eye, and the vision may fail.

On Examination : At the onset the temperature is found to be raised to about 101° F. (38.3° C.), and the pulse to 90 or 100. Definite signs soon appear and the patient becomes very ill. There is protrusion usually of both eyes, swelling of the eyelids and œdema of the conjunctivæ, and the eyes protrude between the closing eyelids (chemosis). The eyelids themselves are œdematous, and may be bluish. The swelling may spread to the forehead and side of the face. External oculomotor paralysis is commonly found, the VI nerve being often first affected, and the pupils may be dilated and fixed. The infection sometimes travels back to the transverse sinus, causing pain behind the ear and œdema over the mastoid process. It may spread even further to the internal jugular vein, when there is stiffness, pain and swelling of the neck. The cerebrospinal fluid : This is often under increased pressure, and contains an excess of polymorphonuclear cells and organisms.

Transverse Sinus Thrombosis. The patient frequently has been suffering from chronic suppurative otitis media or a mastoid operation may have been performed. He complains of headache or vomiting.

On Examination : There may be no otorrhœa, the temperature rises, and is swinging in type, but the pulse is often slow. Frequently there are no other signs, but papilloœdema may be present. If the infection spreads to the internal jugular vein, the patient will notice difficulty in turning the head to the opposite side, and the vein is often felt thrombosed. There may also be œdema over the mastoid process.

Superior Sagittal Sinus Thrombosis. The patient complains of headache, vomiting or bleeding from the nose.

On Examination : The anterior fontanelle is seen bulging in infants, and there is often enlargement of the veins on the front and side of the head. Convulsions and spastic paralysis of both legs may rapidly ensue. There may be papilloœdema, squint or otitic hydrocephalus. The patient usually becomes delirious and incontinent. The cerebrospinal fluid : In infants this is usually clear and under increased pressure with an increase of lymphocytes.

Differential Diagnosis. In cavernous sinus thrombosis the bilateral proptosis with swelling of the eyelids is very characteristic. Proptosis associated with retro-orbital tumours is usually afebrile. It should always be remembered that with sphenoidal sinusitis, in which the cavernous sinus is not affected, there may be swelling of the eyelids, bulging eyes and headache. Transillumination, X-ray examination and exploratory puncture should serve to differentiate. Further, cavernous sinus thrombosis may occur without proptosis. It is not usually possible to diagnose transverse sinus thrombosis with certainty apart from exploratory operation. Examination of the cerebrospinal fluid will

and signs vary according to the site of the tumour and will be considered regionally.

1. *Pre-frontal Region.* An alteration in mentality may be noted. There may be drowsiness, lack of orientation for time, or a tendency to make jokes (*Witzelsucht*). At times yawning, stiffness of the neck muscles, tremor of the homolateral hand, diminution of the heterolateral abdominal reflex, frequent nose rubbing and incontinence of urine or faeces at night may be found. The "grasp-reflex" ("forced grasping" or "groping") may be demonstrable. An object placed on the palm of the hand, on the side opposite to the cerebral lesion, between the thumb and first finger, causes a grasping movement. A similar "grasp-reflex" in the foot may sometimes be elicited with a tumour situated in the medial aspect of the frontal lobe and in the corpus callosum. The "grasp-reflex" of the foot is elicited by light pressure applied to the plantar surface of the foot, especially in the area of the ball of the big toe. The reflex consists in flexion and adduction of the toes, of a tonic nature, lasting for 15 seconds or longer. There may also be inversion of the foot. The reflex is normally present in all infants under the age of 9 months, and disappears in the vast majority of cases by the age of 2 years. It is present abnormally when a lesion interferes with the fronto-pontine fibres. It is therefore probably a release phenomenon, and not a reflex, and consists of low grade volitional movements. The movements do not occur in infants during sleep, nor in adult patients when unconscious. Pressure symptoms include anosmia, resulting from pressure on the olfactory nerve or bulb, and central scotoma with primary optic atrophy may occur on the side of the lesion and papilloedema in the other eye (Foster-Kennedy syndrome).

2. *Ascending Frontal Region.* Irritative or paralytic phenomena may be noted. A cortical tumour may cause Jacksonian epilepsy, with movements starting at the angle of the mouth, or in the thumb or big toe on the opposite side. There may be conjugate deviation of the eyes away from the affected side. With subcortical tumours there may be paralysis of an arm, leg or part of the face. With left-sided lesions aphasia may be present.

3. *Parietal Region.* The patient may notice an awkwardness in movement, or blunting of sensation on the opposite side of the body. Pain and temperature sensations are not affected, but there may be loss of postural sense in the opposite limbs, with astereognosis and disability in the discrimination of two points, as judged by the compass test. Word-blindness may also result from a tumour involving the supra-marginal or angular gyri on the left side.

4. *Uncinate and Hippocampal Region.* If the uncus is involved there may be uncinate fits, the patient passing into a dreamy state with unpleasant sensations of taste or smell, and at times movements of the lips. The growth may extend into the optic radiation, with resultant quadrant homonymous hemianopia. When the left superior temporal gyrus is affected the patient may experience difficulty in naming objects, although he recognises the correct name when it is said (nominal aphasia).

5. *The Occipital Region.* Involvement of the area around the

child may be apparently perfectly well, when suddenly he falls unconscious owing to a hæmorrhage into a glioma. The symptoms and signs are divided into two groups, general and focal. Often the general symptoms are first noted, but in some cases, especially in cerebello-pontine tumours and in the aged, general symptoms are inconspicuous. *The general symptoms and signs* are an index of raised intracranial pressure, and include headache, vomiting and papilloedema. These three are present together in about 60% of all cases of cerebral tumours, and headache alone usually in the remainder. The headache: At first this is paroxysmal and often worse on stooping or at night. Later it becomes persistent. The site of the pain rarely serves to localise the tumour. The skull may be tender on percussion over the tumour. The headache is due to stimulation of the dural branches of the V nerve, by stretching of the dura. The vomiting: This is typically projectile, occurring apart from meals, at night or early in the morning. At times it is not projectile and there is also nausea. Vomiting results from stimulation of the centre in the medulla oblongata. Papilloedema: This may exist in a marked degree without visual disturbance; later, sight is blurred and blindness ensues with atrophy of the optic nerves. The papilloedema is due to the pressure of the cerebrospinal fluid in the sheath of the optic nerve on the central vein of the retina. It is almost always present in cerebellar, fourth ventricle and temporal lobe tumours. The pulse tends to be slow, the temperature subnormal, and respiration of the Cheyne-Stokes type. With tumours of the posterior fossa there is nearly always tachycardia. In some cases, if the skull is shaved, dilated veins are apparent in the scalp over the tumour, and in children the sutures may be widened. A radiogram of the skull may show thinning of the bone (beaten silver appearance), calcification of a meningioma, or displacement of the pineal body. In about 60% of adults over the age of 25 years the pineal body is sufficiently calcified to be shown on X-ray examination. It is situated in the mid-line above and behind the sella. Ventriculography or encephalography may reveal an obstruction in, or displacement of the ventricular system of the brain. Arterial encephalography (arteriography) will show blood vessels displaced by a tumour. The electro-encephalogram may also aid in the localisation of cerebral tumours. Slow delta waves arise in the cerebral tissue surrounding the tumour, when the tumour causes progressive destruction of cortical tissue. Discrete and non-progressive cortical lesions, or deep tumours not affecting the cerebral hemisphere or the cortex, are not likely to be unmasked by electro-encephalography. The site of origin of the abnormal delta waves can be localised by a series of electro-encephalograms. Radio-isotopes, which concentrate in the cerebral tumour, are being used for the localisation of brain tumours. In all cases of cerebral tumour it is dangerous to perform lumbar puncture if the intracranial pressure is raised, as there is risk of death from incarceration of the cerebellum and medulla oblongata in the foramen magnum. A tumour distant from the pituitary fossa may cause signs of hypopituitarism. The increased pressure of the cerebrospinal fluid distends the floor of the third ventricle and causes pressure on the pituitary. *Focal symptoms*

encephalitis lethargica, hypertensive encephalopathy, lead encephalopathy, hydrocephalus or abscess secondary to bronchiectasis may all require to be eliminated. The Wassermann reaction is helpful in establishing a diagnosis of a gumma, especially if the response to anti-syphilitic treatment is good. Secondary malignant deposits in the brain are suggested by the discovery of a primary focus elsewhere.

Course and Complications. The course is usually steadily progressive, but sudden exacerbations of symptoms due to œdema may be expected. In some cases improvement occurs, owing to absorption of œdematous fluid. Complications include internal hydrocephalus, hemorrhage, meningitis and secondary hypopituitarism.

Prognosis. This is always very grave, and the outlook if surgery is adopted is usually gloomy. Cerebral tumours as a class do not lend themselves to excision owing to their ill-defined margins. The most favourable, as judged by the survival period after operation, is the pituitary adenoma, for over 70% of patients survive the operation by 7 years. Next come the cerebellar astrocytoma, the acoustic tumour and the meningioma. The medulloblastoma is malignant. Extra-cerebral tumours are more amenable to removal without damage to the brain. An operation which removes the tumour, but results in the patient becoming hemiplegic and aphasic, can neither be considered successful nor justifiable. The outlook is hopeless with secondary malignant tumours. A gumma responds very poorly to medical treatment and a tuberculoma may at times become obsolete.

Treatment. The Wassermann reaction should be determined, and, if positive, a course of treatment given, as described on p. 600. If the tumour is localised, accessible, and of suitable type, an attempt may be made to remove it surgically. Decompression alone is a palliative measure to save sight and relieve headache. In any case in which an operation is considered inadvisable, the effect of a course of iodides should be tried. Headache, vomiting and semi-coma may be temporarily relieved by the rectal injection of 8 fl. oz. (240 ml.) of 25% mag. sulph. solution, or by the intravenous injection of 25 ml. of 30% sod. chlorid. solution, or of 100 ml. of 50% sucrose solution. These intravenous injections should be given at the rate of 3 ml. a minute. Pain is relieved by aspirin 10 gr. (0.6 G.) t.d.s. or by pethidine 100 mg. or morphine $\frac{1}{4}$ gr. (15 mg.) injected as required. Vascular tumours, such as a venous angioma and arteriovenous aneurysm, should be treated by deep X-rays.

Abscess of the Brain

Definition. Localised suppuration in the brain.

Etiology. The abscess may be due to : 1. Direct spread of infection. This is the commonest cause. The septic focus is most often in the ear, as in chronic otitis media, or in the mastoid air-cells. In other cases the abscess is secondary to infection of the frontal, ethmoidal or sphenoidal sinuses. Syphilitic or tuberculous caries of the skull, and erysipelas or a carbuncle on the scalp, face or neck, may lead to cerebral abscess. 2. Blood-borne infection. The septic focus is frequently intrathoracic, such as bronchiectasis, lung abscess or empyema.

calcarine sulcus may result in homonymous hemianopia. Visual hallucinations, such as flashes of light, may also occur.

6. *The Internal Capsule.* Involvement of the anterior limb causes hemiplegia on the opposite side. If the tumour affects the posterior limb there will be contralateral hemianæsthesia or hemianopia.

7. *The Thalamus.* A tumour destroying the thalamus may result in the "thalamic syndrome." There is weakness of the opposite side of the body and choreic or athetoid movements may be seen. Severe pains may be felt on the opposite side of the body and sensation is altered. Such stimuli as tickling or scraping, or the extremes of heat and cold, may provoke very severe reactions, although the patient is not able to differentiate between the blunt and sharp end of a pin. There is also astereognosis and loss of postural sense on the opposite side.

8. *The Third Ventricle.* A colloid cyst produces intermittent symptoms, especially very severe headache which may terminate in unconsciousness. There is papilloedema with gradual failure of vision.

9. *The Mid-brain.* A tumour in the region of the superior colliculi may cause bilateral ptosis, with weakness of up and down movements of the eyes and a sluggish pupil reaction. There may also be hemiplegia on the opposite side, and bilateral ataxy of the arms, if the decussating superior cerebellar peduncles are involved. Bilateral deafness may result from involvement of the inferior colliculi.

10. *The Pons.* The V, VI or VII nuclei may be affected with paralysis of the muscles supplied by them. There may also be hemiplegia and possibly hemianæsthesia on the opposite side of the body. The pupils are often small, due to interference with the impulses which cause dilatation. These pass down the mid-brain and spinal medulla (cord) to emerge in the cervical sympathetic.

11. *The Medulla Oblongata.* There may be unilateral or bilateral paralysis of the IX, X, XI and XII nuclei, with disturbance of swallowing, mastication and speech. Both corticospinal tracts may also be involved, with bilateral hemiplegia.

12. *The Interventricular Region.* It is not usually possible to diagnose during life tumours arising here.

13. *Cerebellar and Cerebello-pontine Regions.* Tumours of these areas are considered on p. 380.

14. *The Pituitary Body.* These tumours are considered on pp. 719 and 720.

Differential Diagnosis. The diagnosis of a cerebral tumour is often very difficult. Thus localised or generalised convulsions may occur for years with a subcortical tumour. These are usually considered to be due to epilepsy or to hysteria, until papilloedema appears. Vomiting may also be considered a hysterical manifestation. Papilloedema may be met with in nephritis, severe hypertension, septicæmia or severe anæmia. When there are localising signs in the brain other conditions such as a vascular lesion or an abscess must be considered. An abscess may run an afebrile course, but the blood usually shows a leucocytosis. In acute cases, the acute variety of multiple sclerosis,

8. *The stage of localised signs.* Whether or not localising signs appear depends upon the site of the abscess. If it is in the outer surface of the temporal lobe, there may be deafness on the opposite side, or if it is on the left side of the brain there may be word deafness, the patient not appreciating the meaning of spoken words, or having difficulty in naming objects. Pressure on the corticospinal tract in the pons may result in weakness on the opposite side of the body with an extensor plantar response, or loss of the abdominal reflex on the other side of the body. Extension forwards may cause weakness of the lower part of the face on the opposite side. In some cases there is pressure on the III or VI cranial nerves on the same side. An abscess in the occipital lobe may cause homonymous hemianopia, whereas if it is situated in the parietal lobe the patient may lose the power of recognising the shape of objects by touch (astereognosis). An abscess in the precentral gyrus will cause motor paralysis of the opposite side of the body. The symptoms of a cerebellar abscess are described on p. 381. Some degree of papilloedema may develop. 4. *The terminal stage.* This usually implies the phase of coma. The abscess may rupture intraventricularly, with convulsions, delirium, a high temperature and rapid action of the heart, followed by death in a few hours. Meningeal rupture is indicated by signs of meningitis.

Differential Diagnosis. It is often extremely difficult to diagnose with certainty the presence of a cerebral abscess in cases of chronic suppuration in the ear. Mastoiditis and meningitis must be excluded, and they may co-exist with cerebral abscess. The examination of the cerebrospinal fluid establishes or excludes the presence of meningitis. Further, sinus thrombosis may cause difficulties in diagnosis. There is usually a sudden onset of the symptoms in sinus thrombosis, with rigors, a high temperature, rapid pulse, and at times local tenderness. With a cerebral tumour papilloedema is likely to occur early, and to be more intense than is the case with a brain abscess. Leucocytosis is generally absent, and no primary cause for an abscess is discovered. A hæmorrhage into a glioma may cause acute symptoms, resembling those produced by a brain abscess.

Course and Complications. Acute abscesses are usually rapidly fatal. A chronic abscess may be encapsuled for years and give rise to no symptoms until it suddenly bursts into a ventricle or into the subarachnoid space. Complications include pyocephalus, hydrocephalus, cerebral sinus thrombosis, meningitis and septicæmia.

Prognosis. A cerebral abscess which causes symptoms will result in death unless drained surgically. The mortality rate has been lowered to about 10% by the use of antibiotics.

Treatment. This is surgical. In acute abscesses better results are obtained by aspiration than by drainage. Benzylpenicillin, 100,000 units (60 mg.) per ml., may be injected into the abscess cavity after aspirating some pus, and its extent outlined by radiography after injecting into it 1 or 2 ml. of a contrast medium such as diodone. Cure can be effected in some cases by repeated aspirations with penicillin replacements. In addition, a course of intramuscular injections of

In other cases the cerebral abscess is secondary to osteomyelitis, puerperal sepsis, bacterial endocarditis, pyonephrosis, etc. 3. Local trauma. The brain may be injured by a gun-shot wound or a stab. In some cases an abscess follows a blow on the head, although neither skull nor scalp are severely damaged. 4. Local lesions. A cerebral neoplasm or tuberculoma rarely suppurates. A cerebral abscess is most often met with between the ages of 11 and 35 years.

Pathology. A solitary abscess is usually due to trauma or to intrathoracic suppuration, and multiple abscesses to extrathoracic suppuration. A localised intracranial abscess is also found either extradurally between the dura and the skull, or subdurally between the dura and pia. The cerebral abscess may be acute or chronic. The acute abscess contains creamy or blood-stained material, the chronic abscess is filled with greenish offensive pus and usually has a capsule formed by inflammatory tissue. Various organisms, such as staphylococci, pneumococci, streptococci and the *E. coli* may be present, or the contents may be sterile. The *Streptothrix actinomyces* is rarely found. The abscess varies in size from a minute spot to that of a large orange. It usually forms in the white matter below the cortex, which is comparatively avascular, between the brain tissue supplied by the end branches of the cortical and central cerebral arteries. When the cerebral abscess is secondary to infection in the soft tissues outside the skull, the infection may spread along thrombosed emissary veins. An abscess of the brain secondary to osteitis of the skull is usually due to spread of infection along the perivascular spaces.

Clinical Findings. There is often a history that the patient has suffered from chronic suppurative otitis media for some years. The onset of abscess formation may be heralded by cessation of discharge from the ear. In some cases certain stages can be recognised clinically. These are: 1. *The stage of onset.* This may be of short duration, only 1 or 2 days, during which the patient does not feel well; there may be shivering or even a rigor, with headache and perhaps nausea or vomiting. The temperature rises to 101° F. (38.3° C.) or higher, but the pulse remains comparatively slow. 2. *The latent stage.* This may last for a few weeks. The patient feels drowsy, and complains of a dull headache, and his appetite is poor.

On Examination: Local tenderness may be found on tapping the skull at some point. The pupil may be dilated on the affected side. Mental changes such as delusions, hallucinations, irritability, etc., have been described in some cases. The temperature is usually low, but if it is charted every 2 hours, an irregular swing may be detected just above or below the normal line. The pulse may drop to about 60 for short periods during the 24 hours. The blood: There is usually a leucocytosis of 15,000 or 20,000 per c.mm. The cerebrospinal fluid: This is often under increased pressure, and there is an increase of polymorphonuclear cells. The chloride figure may be low. The fluid is sterile. The use of sulphonamides and of penicillin in the treatment of infections predisposing to cerebral abscess has very largely eliminated the preliminary stages. The first symptom may be headache, followed by a convulsion.

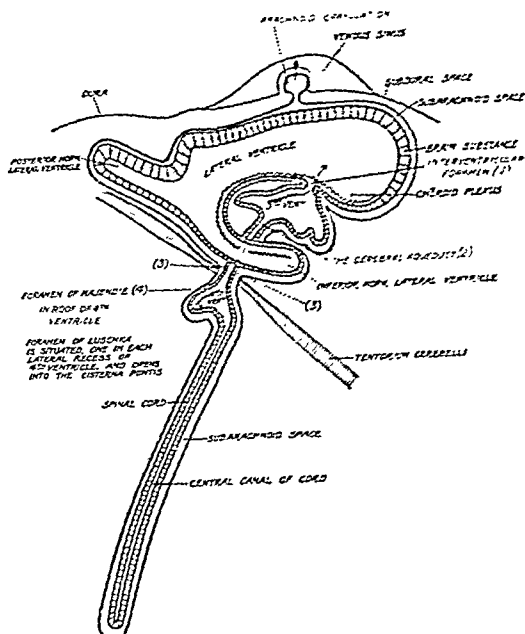


FIG. 32. DIAGRAM INDICATING THE STRUCTURES CONCERNED IN THE PRODUCTION OF HYDROCEPHALUS.

Obstruction at (1), interventricular foramen, causes distention of one lateral ventricle.

Obstruction at (2), cerebral aqueduct, causes distention of both lateral ventricles and of the 3rd ventricle.

Obstruction at (3), tentorium cerebelli, causes communicating hydrocephalus, with distention of the lateral, 3rd and 4th ventricles a communication being patent through the foramina of Majendie and Luschka, with the subarachnoid space around the spinal medulla (cord) and the ventricular system. The fluid passing from the 4th ventricle to the subarachnoid space cannot reach the subarachnoid space above the tentorium where absorption normally chiefly occurs.

Obstruction at (4), foramina of Majendie and Luschka, causes non-communicating distention of the lateral, 3rd and 4th ventricles.

60,000 units (36 mg.) of benzylpenicillin should be given every 3 hours for 7 to 10 days. A chronic abscess may be drained immediately.

Hydrocephalus

Definition. Distension of the ventricles of the brain with cerebrospinal fluid.

Etiology. Theoretically the distension might arise from various causes, such as : 1. Over-production of cerebrospinal fluid. 2. Blockage of an exit from a ventricle. 3. Obstruction to the absorption of cerebrospinal fluid. The majority of cases in practice are due to 2 or 3. *Predisposing causes:* 1. Age. Usually infants or young children. 2. Heredity. Congenital hydrocephalus may run in families, as in the case of the children of Queen Anne.

In order to understand how these causes operate, it is necessary to outline the physiology of the circulation of the cerebrospinal fluid.

Physiology and Pathology. The cerebrospinal fluid is derived, by secretion and filtration, from the blood circulating through the choroid plexuses in the lateral, third and fourth ventricles. These vessels lie invaginated in folds of the pia mater. The fluid leaves the fourth ventricle by the median and lateral apertures in its roof (foramina of Majendie and Luschka), and passes out into the subarachnoid space, which here constitutes the cisterna cerebellomedullaris. It then circulates around the brain and spinal medulla (cord). In order to reach the brain it passes through a channel in the subarachnoid space, at the level of the tentorium cerebelli and so reaches the cisterna pontis and cisterna interpeduncularis, and passing thence over the brain, absorption occurs, again probably by filtration, through the arachnoid granulations into the venous sinuses of the skull. Hydrocephalus may be congenital or acquired, and certain varieties are described.

External Hydrocephalus. This is a misnomer; serous fluid accumulates in the subdural space, leading to atrophy of the brain, as in senile atrophy or general paralysis of the insane. The cerebral ventricles may also be dilated, constituting compensatory hydrocephalus.

Internal or Hypertensive Hydrocephalus (see Fig. 32). 1. *Increased production of fluid.* Obstruction to the venous circulation in the brain may increase the output of fluid from the choroid plexuses to the ventricles. Thus the great cerebral vein, which drains the choroid plexuses of the lateral and third ventricles, might be compressed by a subtentorial tumour. 2. *Obstructed circulation of fluid.* Obstruction of one interventricular foramen (foramen of Monro) will cause dilatation of the corresponding lateral ventricle. This may be due to a tumour of the choroid plexus, and it may be intermittent. Obstruction of the cerebral (Sylvian) aqueduct, as by a tumour, will result in dilatation of the third ventricle and both lateral ventricles. Obstruction of the subarachnoid space, as by meningeal adhesions, at the level of the tentorium cerebelli, causes a "communicating hydrocephalus." The fluid which leaves the fourth ventricle through the foramina in its roof, cannot pass above the tentorium to be absorbed. Normally only one-fifth of the absorption

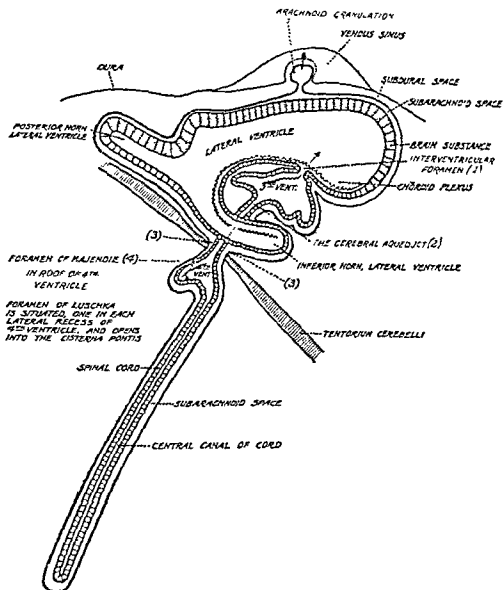


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External Hydrocephalus. This is a misnomer ; serous fluid accumulates in the subdural space, leading to atrophy of the brain, as in senile atrophy or general paralysis of the insane. The cerebral ventricles may also be dilated, constituting compensatory hydrocephalus.

Internal or Hypertensive Hydrocephalus (see Fig. 32). 1. *Increased production of fluid.* Obstruction to the venous circulation in the brain may increase the output of fluid from the choroid plexuses to the ventricles. Thus the great cerebral vein, which drains the choroid plexuses of the lateral and third ventricles, might be compressed by a subtentorial tumour. 2. *Obstructed circulation of fluid.* Obstruction of one interventricular foramen (foramen of Monro) will cause dilatation of the corresponding lateral ventricle. This may be due to a tumour of the choroid plexus, and it may be intermittent. Obstruction of the cerebral (Sylvian) aqueduct, as by a tumour, will result in dilatation of the third ventricle and both lateral ventricles. Obstruction of the subarachnoid space, as by meningeal adhesions, at the level of the tentorium cerebelli, causes a "communicating hydrocephalus." The fluid which leaves the fourth ventricle through the foramina in its roof, cannot pass above the tentorium to be absorbed. Normally only one-fifth of the absorption

takes place from the sub-arachnoid space below the level of the tentorium, and four-fifths above this plane. The pressure therefore rises both in the ventricles, which dilate, and in the subarachnoid space around the spinal medulla (cord), as shown by lumbar puncture. Obstruction of the foramina in the roof of the fourth ventricle as by meningeal adhesions, causes dilatation of the fourth, third and the lateral ventricles. 3. *Defective absorption.* This is not often a cause of hydrocephalus. It may result from an inflammatory obstruction of the arachnoid granulations, by a generalised increased intravenous pressure in the skull due to a tumour, or by thrombosis of the superior sagittal sinus (see otitic hydrocephalus, p. 317).

In congenital hydrocephalus a structural defect may be present, such as a cerebral aqueduct with an opening in its roof; or a scar may cause obliteration of the aqueduct; or the subarachnoid space may be obliterated by adhesions resulting from a hæmorrhage at birth. Less often the foramina in the roof of the fourth ventricle are obliterated by adhesions. In many cases no cause is found. In acquired hydrocephalus the lesion may result from syphilitic or meningococcal meningitis, cerebral tumours, especially those situated in the posterior cerebral fossa, and rarely from thrombosis affecting the great cerebral vein or the cerebral venous sinuses. The normal amount of cerebrospinal fluid present is about 150 ml., with hydrocephalus this is usually increased 3 or 4 times, but much larger quantities have been found. The lateral ventricles may be greatly dilated, the brain substance being reduced to a thin layer.

Clinical Findings. Congenital Hydrocephalus. The head may be abnormally large at birth causing difficulty in labour, or the enlargement may not be noted until a few days after birth. The skull bones become separated, the scalp is thin and translucent, the veins being prominent and the hair scanty. The infant's face is dwarfed by the protruding forehead, and the lower lids may partly cover the pupils of the eyes, owing to downward pressure on the eyes by the orbital plates of the skull. In a severe case the infant cannot lift its head off the pillow. Other congenital defects may be present, such as hare-lip, cleft palate, spina bifida and imperforate anus, etc. The infant may suffer from convulsions and some degree of spastic paraplegia. If the infant survives, mental deficiency or blindness due to optic atrophy may be found.

Acquired Hydrocephalus. The patient may be a young child or an adult of any age. If the hydrocephalus develops after the skull bones have firmly united there is no enlargement of the head; if bony union is not complete some enlargement may occur. The patient complains of very severe headache, vomiting, disturbance of vision and unsteadiness or giddiness.

On Examination: Papillædema may be present, and in some cases there is weakness of the arms or legs of a spastic type with exaggeration of the deep reflexes, and an extensor plantar response.

Differential Diagnosis. The diagnosis of congenital hydrocephalus usually presents no difficulty; slight cases should not be mistaken for

regarding the physiology of speech. The older physiologists believed in definite cortical centres, such as a motor speech centre, connected with the area of the brain controlling the speech muscles, a motor writing centre connected with the hand, a sensory visual centre and a sensory auditory centre connected with the eye and ear respectively, the whole area comprising the speech zone (see Fig. 33). The modern tendency is to regard the subcortical zone with its association fibres as being intimately concerned with speech and writing faculties. Thus Broca in 1861 taught that aphasia is due to a lesion at the posterior end of the left inferior frontal gyrus. Wernicke (1874) postulated, in addition to the motor centre in Broca's area, a visual sensory centre in the

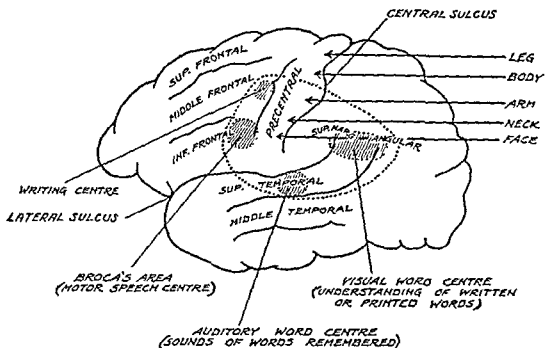


FIG. 33. DIAGRAM OF THE SPEECH CENTRES AND CORTICAL MOTOR CENTRES OF THE BRAIN.

left supramarginal and angular gyri and their subcortical zones, and an auditory sensory centre in the left superior and middle temporal gyri and the subcortical area. Marie (1906) considered that true aphasia is due to a lesion in Wernicke's sensory zone, and that motor aphasia results from a combination of anarthria (disordered articulation) with sensory aphasia. Anarthria is due to a lesion in the neighbourhood of the lentiform nucleus and the genu of the internal capsule. Thus in some cases of motor aphasia no lesion is found post-mortem in Broca's area, and in motor aphasia there is always some intellectual weakness. Head (1910 and subsequently), after extensive study of the subject, introduced certain terms for types of aphasia which are probably cortical in origin. These include verbal aphasia with difficulty in word formation, nominal aphasia with incorrect use of nouns in speech or writing, syntactical aphasia with incoherent or jargon speech, and semantic aphasia in which there is a lack of appreciation of the deeper significance of words and phrases. Work by Goldstein (1948) is concerned

the immediate results of the lesion which has caused the aphasia, his power of speech may be slowly improved by the help of a specially trained speech instructor.

Encephalitis

Definition. Diseases characterised by focal lesions in the grey matter of the brain and central nervous system, often with a disturbance of the sleep mechanism.

Etiology. The causative agent is thought to be a virus, but it has not been isolated in all cases. The following are some of the varieties described:—

1. *Encephalitis lethargica*, now rarely seen. It spread from Vienna to London in 1918. The virus was not isolated.
2. *Epidemic encephalitis*—St. Louis. Due to an anthropod-borne virus, B (2).
3. *Japanese B. encephalitis*, due to arbovirus B (2).
4. *Russian spring-summer encephalitis*, allied to the *loup-ill* complex, due to arbovirus B (3), a tick-borne virus affecting sheep and man.

Encephalitis Lethargica

Pathology. At autopsy the brain often presents no naked eye changes, but the pia mater may be hyperæmic and cedematous, and on section the cortex and the basal ganglia may appear hyperæmic, and actual hæmorrhages are sometimes seen in the grey matter. Microscopically changes are found in the various masses of grey matter. There is a "cuffing" of the small vessels in the grey matter, due to an infiltration of lymphocytes and plasma cells in the perivascular spaces. Nerve ganglion cells may also undergo destruction in localised patches of grey matter. The cerebral cortex is not usually affected.

Incubation Period. This is probably about 8 to 10 days.

Clinical Findings. Certain types are described. The acute type is now seldom seen. Sporadic cases start more insidiously.

Acute Cases. The three main types are: 1. *The somnolent-ophthalmoplegic type.* There are fever, drowsiness and oculomotor palsies. The corticospinal tracts may be involved. 2. *The hyperkinetic type.* There are muscular twitchings and myoclonic or convulsive movements. 3. *The amyostatic-akinetic type.* This is an acute form of Parkinsonism, with rigidity and absence of movement. There may be tremors, sialorrhœa and sleep inversion.

Certain other forms of the acute disease will be enumerated, such as: 4. *The apoplectiform type.* The patient is suddenly stricken, as by a cerebral hæmorrhage and may die at once. 5. *The cerebellar type,* with marked ataxia. 6. *The acute bulbar type,* with disturbance of speech and swallowing. 7. *The acute neuritic type,* with paresis of the face and limbs. 8. *The visceral type,* with abdominal crises resembling those of tabes dorsalis. 9. *The monosymptomatic type.* Hiccough may last 5 to 7 days, or there may be trismus or yawning. 10. *The pseudo-tabetic or*

with the complicated functional disturbance occurring in the various types of aphasia. The speech area of the brain is supplied by an orbital branch (Sylvian artery) of the left middle cerebral artery. The usual lesion is a thrombosis, embolus less often causes aphasia, a hæmorrhage so frequently results in death that aphasia cannot be observed. Aphasia of insidious onset may be due to a tumour. Transitory aphasia may result from epilepsy, migraine, uræmia, general paralysis of the insane, or encephalitis lethargica.

Clinical Findings. In the majority of cases the aphasia has a sudden onset and is associated with other symptoms of a "stroke." There are various clinical types of aphasia, such as 1. *Motor aphasia*. The patient is unable to speak intelligibly, but the actual muscles involved in speech are not necessarily paralysed. Often he can say a few simple words, and he can understand what is said to him. 2. *Nominal aphasia*. The patient may not be able to name an object which he recognises. He can realise, however, whether or not it is correctly named by someone else. 3. *Agraphia*. The patient cannot write, although the hand muscles which are controlled by the adjacent cortical area in the precentral gyrus are not paralysed. 4. *Anarthria*. Disordered speech may be due to a bilateral cortical lesion, or a bilateral lesion of the internal capsule (pseudo-bulbar paralysis), or to a bulbar nuclear lesion. 5. *Word deafness*. Spoken language is not understood, it seems to be a foreign tongue. The patient's speech may be a jargon. 6. *Word blindness* (alexia). The patient can see written words, but does not appreciate their meaning. 7. *Mixed aphasia*. In the majority of cases the aphasia is mixed. There is a disturbance of general intelligence, as well as of speech, writing and understanding of spoken words, and often the patient is also suffering from hemiplegia.

Apraxia and agnosia are conditions closely allied to aphasia. In the former the patient is unable to carry out certain complicated movements, such as buttoning up his clothes. In the latter he confuses the use of objects.

On Examination : A certain routine should be observed in investigating cases of aphasia. A complete neurological examination must be carried out and any lesion which is detected can often thus be localised. An enquiry should be made as to whether the patient is right or left-handed. The power of speech should next be tested by asking the patient to say how he feels, etc. If he cannot speak intelligibly his power of understanding spoken words should be tested by asking him questions, making him indicate his answers by signs or writing. The power of understanding written or printed words is then determined by giving him a paper to read, and asking him if he understands it. He is asked to write, to repeat words spoken to him, to copy words, pick out named objects, to name objects, and to write from dictation. In this way the various connecting links of the speech area of the brain are tested.

Prognosis. This naturally depends upon the nature of the lesion. If it is not a hæmorrhage or a tumour, there is usually a tendency to improvement, but subsequent attacks are liable to occur.

Treatment. When the patient has recovered from the shock and

spinal fluid: This is often normal, but in some cases there is an excess of cells and protein.

8. Spontaneous Encephalomyelitis. The patient is usually a young adult who is suddenly taken ill, either with pains in the body or limbs, or with weakness of the legs. There is often a spastic paresis or paraplegia, with exaggerated or lost deep reflexes, and usually an extensor plantar response. There may be sensory loss in one or both legs, or a Brown-Séquard syndrome with paralysis of one leg and loss of sensation on the other side. There is usually retention of urine. The cranial nerves are seldom affected, but there is often nystagmus. In some cases meningeal symptoms are present, or there may be aphasia and hemiplegia. The cerebrospinal fluid is normal.

Differential Diagnosis. The disease is probably distinct from acute multiple sclerosis. Thus the fever, shooting pains, loss of pain and temperature sensations, the normal cerebrospinal fluid, and, at times, loss of deep reflexes in the legs during the acute stage and euphoria, are in favour of encephalomyelitis. In acute multiple sclerosis there is more likely to be diplopia, loss of postural and vibration sensations in the leg, and retrobulbar neuritis. Other conditions which may require exclusion are poliomyelitis, encephalitis lethargica, meningitis and encephalitis due to the virus of herpes simplex.

Course and Complications. The disease may pursue a rapidly fatal course, or there may be recovery, after an acute illness lasting 1 or 2 weeks. Sequelæ include a persistent Brown-Séquard syndrome, a condition resembling chronic multiple sclerosis, hemiplegia or aphasia.

Prognosis. The mortality rate varies from 10% to 50%.

Treatment. The patient must be kept in bed and symptomatic treatment applied. In post-vaccinal encephalomyelitis 5 to 30 ml. of serum, obtained from an individual successfully vaccinated 14 days previously, should be injected intravenously, or into the spinal sub-arachnoid space after lumbar puncture. If the patient is comatose 25 to 100 ml. of 25% sucrose solution should be injected intravenously. In encephalomyelitis following measles 10 ml. of convalescent serum should be injected intramuscularly and repeated if necessary. The value of serum treatment is very doubtful.

Encephalitis Periaxialis Diffusa

(Schilder's Disease)

Definition. A disease characterised by inflammatory changes in the white matter of the brain, with demyelination of nerve fibres.

Etiology. This is a rare disease, the cause of which is unknown. Children and young adults are chiefly affected.

Pathology. The brain often appears small. On section, sharply defined patches of greyish or reddish-brown hyaline appearance are seen in the white matter. The occipital and temporal lobes are especially likely to be affected. Lesions also occur in other parts of the cerebrum, and these may coalesce. The cerebellum is sometimes affected. Micro-

pseudo-paralytic type, with Argyll Robertson pupils and absent ankle- and knee-jerks. 11. *The meningitic type*, with symptoms of meningism. 12. *The psychotic type*, the initial acute delirium suggesting a psychosis.

Chronic Cases. The manifestations of the chronic form of the disease may directly follow an acute attack, or they may only appear after an interval of several years. In some instances the acute stage of the disease was so slight that it was not recognised as anything beyond a mild feverish illness or a temporary diplopia. The symptoms of the chronic disease are due to destruction of nerve cells, and take the form either of Parkinsonism or of juvenile pseudo-psychopathia.

This disease is now chiefly of historical interest and a full description will not be given.

The symptoms of the other types of encephalitis include headache, fever, drowsiness, coma, delium, vomiting, convulsions and cranial nerve palsies.

Acute Disseminated Encephalomyelitis

Definition. Inflammation affecting the brain and spinal medulla (cord).

Etiology. Certain types are described: 1. *Post-vaccinal*. A complication of vaccination against small-pox and rabies. 2. *After infectious fevers*, such as measles, chicken-pox, mumps, small-pox, scarlet fever, diphtheria and whooping-cough. 3. *Spontaneous*, with no known cause.

Pathology. The surface of the brain may appear congested, and on section punctate hæmorrhages may be seen. Microscopically, there is a diffuse infiltration of the perivascular spaces with round cells and plasma cells, and demyelination of the white matter may be present around the vessels. The pons, medulla oblongata and lumbar part of the spinal medulla (cord) are especially liable to be affected.

Clinical Findings. 1. *Post-vaccinal Encephalomyelitis.* The symptoms usually begin 10 to 12 days after a primary vaccination in a child over the age of 1 year or in an adult. The risk of post-vaccinal encephalomyelitis under the age of 1 year is negligible. The patient complains of malaise, headache and vomiting. The temperature rises to over 102° F. (38.9° C.), the legs become paralysed, and the plantar responses may be extensor. There may be neck rigidity, convulsions and trismus. The cerebrospinal fluid pressure is increased and there may be an excess of protein and of mononuclear cells. There is later incontinence of urine and fæces in cases which die in coma. The patient may recover completely, or die in a day or so, or recovery may be incomplete with residual states, such as hemiplegia.

2. *Encephalomyelitis associated with Infectious Fevers.* The symptoms occur as a complication of measles, mumps, small-pox and chicken-pox; the legs may rapidly become paralysed, and there is retention of urine. The paralysis may be flaccid with diminished reflexes, and later spastic with increased reflexes, and an extensor response. There may also be dissociated anæsthesia of the legs, pain and temperature sense being lost, and touch, vibration and postural sense being unaffected. In other cases there are convulsions with headache. The cerebro-

tracts is seen. Multiple small cysts (porencephaly) are at times present in the brain.

Clinical Findings. No symptoms are usually noticed at birth. The infant does not begin to walk until after the normal age (1 year). It is then noticed that the legs are weak.

On Examination: There is spasticity of the legs, with an increase of the deep reflexes. The extensor plantar response of the infant is perpetuated. Later the heels become raised, and the child cannot walk on them, the legs are adducted, and may actually cross one another on walking (scissors gait). The arms are rarely affected. In the majority of cases the mentality of the child is normal. In other cases mental deficiency, athetoid movements or epileptiform fits may occur. There is usually a tendency to improvement, but death may result from some intercurrent disease.

Treatment. In the early stages massage and passive movements should be applied to the affected limbs. Later, contractures may be improved by operations such as tenotomy. Active remedial exercises are useful in the co-ordination of movements. The administration of thyroideum in doses of 1/10 gr. (6 mg.) t.d.s. is of value in many cases.

Amaurotic Family Idiocy

(Cerebro-macular Degeneration. Tay-Sachs Disease)

Etiology. The cause is unknown. The patient is nearly always a Jewish infant. It tends to affect several members of one family.

Pathology. There is degeneration of nerve cells, with deposition of lipid material throughout the brain and spinal medulla (cord). The nerve cells swell and the nuclei are destroyed.

Clinical Findings. The infant appears healthy at birth, but between the age of 8 and 6 months muscular weakness is noticed. This often starts in the back, and becomes generalised. Ophthalmoscopic examination shows a condition of primary optic atrophy, with a cherry red spot at the macula due to atrophy of the retina and exposure of the choroid. The disease is progressive, there is marked mental deterioration, and death occurs in about 6 to 12 months from the onset of symptoms.

The Juvenile Type (Spielmeyer-Vogt's disease). Another type of the disease affects young children, usually not Jews. There is some degree of optic atrophy with retinitis pigmentosa, but the red spot does not appear at the macula.

Tuberous Sclerosis

(Epiloia)

Definition. A congenital disease characterised by mental deficiency, epileptic attacks and adenoma sebaceum.

Pathology. Nodules, resembling glial sclerosis, are found in the cerebral cortex and in the walls of the lateral ventricles. These may calcify. Various tumours are also met with in the retina, kidneys, heart or lungs.

scopically, it is seen that the myelin of the white matter is destroyed, with secondary degeneration of the axis cylinders. An infiltration of round cells and neuroglial cells is present in the white matter, and phagocytes and lymphocytes are gathered around the vessels.

Clinical Findings. The patient is often a child about the age of 8 or 10 years. The symptoms depend upon the area of brain affected; in a typical case the patient is comparatively suddenly taken ill with malaise and headache. There may be early disturbance of vision, giddiness, deafness, or difficulty in walking, or in using an arm.

On Examination: If the cortical motor area is involved there may be spastic weakness of a leg or arm, with exaggerated deep reflexes and an extensor plantar response. With involvement of the occipital cortex there is dimness or loss of vision. Thus both visual fields may be totally blind, or with unilateral lesions there is a homonymous hemianopia. The pupils react normally, and the discs are normal; occasionally there is a slight degree of optic neuritis. When the frontal lobes are affected there may be alteration in mentality, such as childishness or actual dementia. In other cases there is disturbance of speech or aphasia. Jacksonian fits or generalised epileptiform convulsions may occur. The cerebrospinal fluid: This is normal. The temperature is usually normal, but may rise before death.

Differential Diagnosis. The diffusely scattered and spreading nature of the lesions usually serves to differentiate the disease from a cerebral tumour. With the latter, papilloedema is generally more intense.

Course and Complications. The course is usually steadily progressive, arrest being very rare.

Prognosis. The disease is usually fatal either in a few months or in 2 to 3 years.

Treatment. No cure is known.

Cerebral Diplegias

(including *Little's Disease*)

Definition. A disease of infants characterised by spastic diplegia, or spastic rigidity of the arms, trunk and legs.

Etiology. In *Little's disease* the causes are operative before or during birth. They include birth injuries, resulting in meningeal hæmorrhage, asphyxia at birth, hæmolytic disease of the new-born, intra-uterine infections, and faulty development (agenesis) of the corticospinal tracts. In other cases of cerebral diplegia the spasticity develops in early life, often due to encephalitis, and rarely to hypothyroidism. Infantile hemiplegia may be due to hæmorrhage, infections, and possibly to degenerations.

Pathology. Cerebral venous hæmorrhage, or petechial and confluent hæmorrhages, may be found post-mortem. In other cases the gyri of the brain appear atrophied on naked eye examination (atrophic lobar sclerosis), and microscopically, atrophy or sclerosis of the corticospinal

1. *Petit mal* (minor attacks). The patient may be quite unaware of their occurrence. The onlooker notices that the patient suddenly stops speaking or remains motionless for a second or so. He looks dazed, the pupils may dilate, the head moves slightly, the eyes deviate and there may be yawning. The face usually becomes pale and subsequently flushes. The patient then comes round suddenly and continues what he was doing. During the attack there is a brief loss of consciousness.

Pyknolepsy. This is a disease of children closely resembling petit mal. The onset is usually between the ages of 4 and 12 years. The attacks begin quite suddenly and are of very brief duration, lasting only a few seconds. The child has a vacant look and is unable to speak or move. There may be twitching of the eyelids, and the eyes may roll upwards. There are no convulsions and the child does not fall and is not really unconscious. Recovery is sudden and complete. As many as 100 such fits may occur in a day. The attacks usually disappear after puberty and are totally uninfluenced by drug treatment.

The akinetic form. The patient may suddenly fall to the ground without warning, due to loss of postural control (*morbus caducens*). He gets up at once after a momentary loss of consciousness.

Myoclonic jerks. Sudden jerky movements occur of the arms or trunk, without apparent loss of consciousness. These three forms constitute the *petit mal triad*.

2. *Grand mal* (major attacks). In about half the cases there is a preliminary phase known as an aura. *The aura*: This may take the form of auditory, visual, olfactory or gustatory sensations. In other cases numbness or tingling may be felt in one of the extremities, or a sensation of something travelling up the arm or leg. There may be slight muscular twitchings, cramp, sweating, giddiness, or peculiar dreamy states or reminiscent sensations of familiarity with certain places with which the patient is personally unacquainted. These auras indicate the beginning of a fit in some portion of the brain and the process, whether it be one of excitation or inhibition, spreads rapidly, producing unconsciousness and convulsions. These usually affect first the muscles which move the head and eyes and then rapidly become generalised. The patient may give an initial unconscious cry and then fall to the ground. There is marked pallor. *The tonic phase*. This lasts for about half a minute. The muscles are contracted and the attitude is often that of decerebrate rigidity, the arms being flexed and adducted, the legs extended, the head retracted and often turned to one side, and the back arched. Respiration usually ceases with resultant cyanosis. The tongue is protruded and bitten as a result of masticatory spasm. *The clonic phase*. This is characterised by jactitations, violent muscular contractions and relaxations producing convulsions. They may be first noted on one side of the body. Breathing is stertorous and frothy fluid exudes from the mouth, which is blood-stained if the cheeks or tongue have been bitten. The face is contorted, the mouth opening and closing and the eyes rolling upwards. There is frequently enuresis, and the pulse is rapid and of small volume. The pupils are dilated and

Clinical Findings. Convulsions are usually noticed during the first year of life. The adenoma sebaceum appears a few years later, first in the labio-nasal folds, it spreads to the cheeks in a butterfly area, involving later the chin, but not the upper lip. The adenomata tend to coalesce and become dark red or brown. Café-au-lait staining may be seen elsewhere on the skin and a shagreen patch in the lumbo-sacral region. There may also be neurofibromatosis. X-ray examination of the head shows thickening of the skull and calcified nodules in the brain or projecting into the lateral ventricles. The long bones, hands or feet may show periosteal thickening, osteoporosis, or cyst formation.

Prognosis. Death may be delayed for many years, and then result from intercurrent infection, epilepsy or renal tumour.

Treatment. This is devoted to care of the patient on account of the mental deficiency and to treatment for the epileptic fits.

Epilepsy

(Idiopathic Epilepsy)

Definition. A chronic disorder in which there are recurrent disturbances of the chemico-electric activity in the brain associated with attacks of unconsciousness, with or without convulsions, or in which there are psychic seizures, due, in the majority of instances, to no known cause.

Etiology. In some cases an attack may be provoked by a fright. **Predisposing causes :** 1. Age : The majority of cases begin in childhood or about the time of puberty. In about 25% of cases epilepsy begins after the age of 20. 2. Sex : The incidence is equal. 3. Hereditary transmission : The disease is not transmitted, but there is a hereditary trait which is transmitted in a definite proportion of cases. 4. Dyspituitarism, especially of the Fröhlich type. 5. Migraine may be a precursor. 6. Alkalosis. 7. Water intoxication. 8. Menstruation. 9. Anoxæmia and hypoglycæmia. 10. Local cerebral lesions are present in a certain proportion of cases, especially in temporal lobe epilepsy.

Pathology. The electro-encephalogram shows that epilepsy is associated in many cases with the development of abnormal rhythms in the cerebral cortex. It is a paroxysmal cerebral dysrhythmia, in which discharges occur from living neurones. This probably depends upon the metabolism of the neurones. Post-mortem, no changes are found in the central nervous system of patients who have suffered from idiopathic epilepsy.

Clinical Findings. The patient is usually a child or young adult. There may be a history of infantile convulsions. The general health is often good, but the patient is apt to be lazy, egocentric and prone to lying. The speech may be of the "plateau" type, the vowels being pronounced with a peculiar even tone. The clinical findings of idiopathic and organic epilepsy are indistinguishable, and the so-called Jacksonian, or local fits, are met with at times in many cases of idiopathic epilepsy in which there is no local lesion of the brain. Certain types of epilepsy are described :—

patient does not bite his tongue nor micturate. Hysterical attacks may alternate with epileptic ones. 5. *Syncopal attacks*. These are associated with a fall in blood pressure and are usually provoked by some unpleasant sight or thought, or by standing on parade. There is loss of consciousness and convulsions may occur. Stokes-Adams' attacks are associated with cerebral anæmia. 6. *Vasovagal attacks*. These resemble a much prolonged attack of *petit mal*. There is cutaneous pallor and sweating, a slow and feeble pulse, dilated pupils, flaccid muscles, abdominal, cardiac or respiratory discomfort, and the patient may fall. Faints may be associated with epidemic vomiting and diarrhoea. 7. *Narcolepsy*. This may be differentiated from epilepsy. Males are affected slightly more frequently than females, usually about the age of puberty or more rarely about the age of 40, and the disease is very obstinate. It is characterised either by sudden attacks of uncontrollable sleep, or by the cataplectic attacks, with loss of muscle tone. The latter are induced by emotions, especially by amusement. The patient falls, but retains consciousness. He is unable to speak or to move, the lower jaw drops and the eyelids tend to close. After a few seconds or minutes he suddenly recovers. There may be protrusions of the tongue or contraction of the facial muscles, possibly due to the patient trying to speak. The patient usually describes the attack by saying that he "flops." In some cases narcolepsy is complicated by epilepsy. Traumatic cases also occur following blows on the head and possibly result from minute hæmorrhages near to, or in the third ventricle. 8. *The Kleine-Levin syndrome*. There are periodical attacks of somnolence lasting 2 or 3 weeks, accompanied by excessive hunger.

Course and Complications. The course of epilepsy is very variable. Minor attacks may occur frequently and be interspersed with major fits. Major attacks may recur at comparatively long intervals. Complications include post-epileptic phenomena, such as *automatic actions*. Thus the patient may undress after an attack, being quite unaware of his actions. Mania and paralysis may ensue. Rupture of the heart, and fracture or dislocation of the jaw, may occur during the convulsive stage. Mental deterioration is especially likely to follow attacks which begin early in childhood; it does not depend upon the violence of the attacks.

Prognosis. The outlook is usually unfavourable in epilepsy, and spontaneous recovery is comparatively infrequent. The most favourable features are if the attacks begin after the age of 20, and if they are not very severe. Mental deterioration is an unfavourable feature. *Petit mal* is less influenced by treatment. *Status epilepticus* is a very grave event; death may be due to an accident, such as suffocation during a nocturnal attack.

Treatment. Prophylactic. An attack may sometimes be aborted when there is an aura of something travelling up the limb, by tying a bandage around the limb close to the trunk. Firm muscular contraction by clenching the fist may at times avert an attack heralded by a recognised aura. In view of the transmission of a hereditary trait it is inadvisable for epileptics to marry.

Curative: 1. During the attack. No special treatment is usually

do not respond to light, the corneal and deep reflexes are usually abolished and the plantar responses are often extensor. It is believed that the blood pressure falls during an attack. After 3 to 4 minutes the convulsions cease, and the patient falls asleep or rapidly regains consciousness. He does not remember the attack, but may be made aware of it by finding that he has injured himself or that he is in some unusual position, or that he has had incontinence of urine. On recovering consciousness he may complain of severe headache or of nausea or vomiting. There is frequently polyuria with a trace of protein in the urine, and an extensor response may persist for a few hours, with increase of the deep reflexes. In some cases there is a temporary aphasia or post-epileptic paralysis (Todd's paralysis).

3. *Psychic seizures* (psychic equivalents, psychomotor epilepsy). These include peculiar dream states with hallucinations of sight, smell, taste or sound. There may be amnesic states, automatic actions, chewing movements, or stupor. In the third variety there may be jerky movements, rigidity, actions of violence, fugues, or running episodes. In temporal epilepsy there are psychomotor seizures, with an aura which may be olfactory or abdominal. There are often personality changes. The electro-encephalogram shows changes in the majority of patients suffering from epilepsy, even between the attacks. The abnormality between the fits consists in the occurrence of intermittent, irregular slow waves. Seizure waves occur during a fit; in grand mal there are sharp spikes, in petit mal quick sharp spikes alternate with slow round waves, and in psychomotor attacks square flat waves are seen (see Fig. 25). About 20% of epileptics have a normal electro-encephalogram, and in about 12% of normal people the electro-encephalogram is abnormal, although there are no fits.

4. *Status epilepticus*. The patient may pass into a state of coma interrupted by convulsive attacks without recovery of consciousness. The temperature is raised to 104° or 105° F. (40° or 40.5° C.), the pulse is frequent and of small volume, there is rapid bodily wasting and death is likely to occur in a few days from fatty myocardial degeneration or pulmonary oedema.

Differential Diagnosis. Idiopathic epilepsy must be diagnosed from: 1. *Infantile convulsions*. Clinically the convulsive phenomena are alike, and epilepsy can only be excluded by the course of the disease, infantile convulsions being of a temporary nature, epilepsy tending to recur. 2. *Jacksonian epilepsy*. This type is, in some cases, organic and associated with a definite cerebral lesion such as a depressed fracture of the skull, tumour of the brain, gunshot wound of the head, etc. Local fits ensue. In other cases local fits occur in idiopathic epilepsy. 3. *Epileptiform convulsions* associated with uræmia, congenital cystic disease of the kidney, chronic hypocalcæmia following thyroid operations, alcoholism, lead poisoning, cerebral syphilis, general paralysis of the insane, cerebral cysticercosis, etc. 4. *Hysterical attacks*. During these attacks the patient is not completely unconscious. The attacks occur in the presence of onlookers, and the patient does not fall in a dangerous situation. The corneal, pupil and deep reflexes are usually present. The

in 11 m. (0.7 ml.) of water should then be given, and if this does not stop the convulsions an enema may be administered, followed by a rectal injection of $\frac{3}{4}$ to 1 fl. oz. (22 to 30 ml.) of paraldehyde (for an adult) with an equal quantity of olive oil, and the temperature may be lowered by tepid sponging.

General Treatment. The patient should be encouraged to take an interest in outside affairs as far as possible, but mental worry and over-fatigue are injurious. A regular mode of living, with open-air exercise and avoidance of alcohol should be enforced. No epileptic should be allowed to drive a car or engage in any occupation in which he may be a danger to himself or to others. Children of the poorer class are often best treated in special institutions or colonies.

Narcolepsy. This may be treated on the same lines as epilepsy, in some cases good results have been obtained by the administration of ephedrine hydrochloride $\frac{3}{4}$ gr. (50 mg.) three times a day for an adult, and $\frac{3}{8}$ gr. (22 mg.) for a child, or by amphetamine sulphate, 5 mg. tablets, 2 to 18 daily.

Chorea

(Sydenham's Chorea. Rheumatic Chorea. St. Vitus' Dance)

Definition. A disease characterised by spontaneous and irregular muscular contractions, usually associated with an acute rheumatic infection.

Etiology. The cause is not definitely known, but in the majority of cases chorea is believed to be due to a rheumatic infection. It may occur without any clinical evidence of an acute rheumatic infection. It may be associated with scarlet fever, diphtheria, measles and rarely with chicken-pox. **Exciting causes:** 1. Fright. 2. Pregnancy, especially during the first three months of the first pregnancy. **Predisposing causes:** 1. Age: Childhood and adolescence, rare after 25. 2. Sex: Females predominate. 3. Overwork at school and left-handedness. 4. Poverty and unhygienic surroundings. 5. A familial rheumatic tendency.

Pathology. Changes are found in the cerebral cortex, the caudate nucleus, the substantia nigra, the red nucleus and possibly the superior cerebellar peduncles are affected. A focal lesion of the subthalamic nucleus (corpus Luysii) will cause hemichorea on the opposite side. Microscopically there is vasodilatation, at times perivascular cuffing, and degeneration of ganglion cells.

Clinical Findings. The patient is often a child of about the age of 10, who becomes nervous, irritable and unnaturally emotional. She is listless, inattentive and has difficulty with her lessons. There may have been loss of appetite, and sore throat, growing pains or rashes (such as erythema nodosum). In some cases the child seems lame or drags one leg, or is clumsy, and is apt to drop things, and she may have difficulty in speech when excited. Twitching of the face, grimacing, twitching of the hands, or shrugging the shoulders may be the first sign noticed in other instances.

On Examination: The signs vary with the severity of the case.

required for attacks of petit mal. The immediate treatment for an attack of grand mal consists in loosening the patient's collar, removing false teeth if present, and preventing him from biting his tongue by inserting a spoon between his jaws. The patient should not be aroused if he falls asleep after the attack. A patient who is subject to attacks of epilepsy occurring by night should sleep on a low bed.

2. Between the attacks. Bromides and belladonna are now seldom used for the treatment of epilepsy, but they are occasionally effective when other methods fail.

Petit mal. Troxidone (Tridione) is of value. The dose for an adult is 0.3 G. capsule t.i.d., and this may be cautiously increased to 0.9 G. t.i.d. For a child 0.15 G. is given t.i.d., increased to 0.6 G. t.i.d. Side-effects include photophobia, a morbilliform rash, aplastic anaemia, and nephrosis. This drug should be discontinued if a rash appears, and a blood count should be done every month. If Tridione fails paramethadione (Paradione) may be tried in the same doses, the same precautions being taken.

Grand mal. Treatment is usually begun with phenobarbitone, first $\frac{1}{2}$ gr. (30 mg.) once or twice a day, increasing up to 1 gr. (60 mg.) t.i.d. Alternatively, a Spansule containing 1 gr. (60 mg.) or $1\frac{1}{2}$ gr. (90 mg.) of phenobarbitone may be given b.i.d. Drowsiness may be checked by the simultaneous administration of amphetamine sulph. 5 mg. before breakfast and before lunch. It is often found helpful to reduce the dose of phenobarbitone and combine it with phenytoinum sodium (Dilantin, Epanutin, Eptoin) in doses of 0.1 to 0.2 G. t.i.d. for an adult, and 0.01 to 0.1 G. t.i.d. for a child. It is put up in capsules containing Epanutin 0.1 G. with phenobarbitone 0.05 G. Side-effects include hypertrophy of the gums, ataxia, nystagmus, diplopia, skin rashes, neutropenia and delusions.

Primidone (Mysoline) is also of value in grand mal and temporal lobe epilepsy, but of less value in petit mal. It may produce drowsiness and giddiness. The dose for an adult is 0.25 G. daily, increased to 3 or 6 doses in the 24 hours. In very resistant cases methoin (Mesontoin) may be tried in doses for an adult of 0.2 G. t.i.d. It may produce drowsiness or aplastic anaemia and the blood should be examined monthly.

In temporal lobe epilepsy sclerotic areas may be present in the inferior and medial part of the temporal lobe. Treatment has been recommended by excising the anterior part of one temporal lobe. It is claimed that the fits are abolished or reduced in over 50% of cases so operated on. The improvement in personality is not so good as is the diminution in the number of epileptic attacks. Patients with personality changes and aggressive outbursts may be improved by operation. Those with paranoid aggressive states, hysterical reactions, or inefficient personalities are not so improved.

For *status epilepticus* the patient should be kept in bed in a dark room, and an immediate intramuscular injection given of 10 ml., of paraldehyde, for an adult. This is put up in 10 ml. ampoules. Alternatively a subcutaneous injection of phenobarbitone sodium 2 gr. (0.12 G.)

few weeks, but if the condition is overlooked or the child is pressed at her work the disease is prolonged. Recurrent attacks occur in about 30% of cases, often after an interval of a year. A watch should be kept for complications such as endocarditis or pericarditis. Aortic disease rarely occurs. Mitral stenosis may develop many years after an attack of chorea.

Prognosis. This is good, except in chorea gravis and maniacal chorea. In chorea gravis dysphagia is a dangerous symptom, and maniacal chorea is usually rapidly fatal. The gravity of the disease is increased by endocarditis or pericarditis. Abortion is liable to occur in the chorea of pregnancy, and may be followed by the death of the mother.

Treatment. In all cases the child should be taken away from school and kept quietly at rest at home, preferably in bed, unless the disease is very mild. In severe cases precautions should be taken to prevent the child injuring herself by falling out of bed. Adequate nourishment is necessary and milk is of value in this respect. The bowels should be kept open daily. Warm baths tend to relieve the nervous symptoms. There is no specific curative drug. Good results are usually obtained with aspirin in doses of 5 to 15 gr. (0.3 to 1 G.) or more t.d.s. for a child of 10 to 12 years. Penicillin, 250,000 units (150 mg.), should be given by mouth for 10 days. For restlessness phenobarbitone $\frac{1}{2}$ to 1 gr. (30 to 60 mg.) may be given t.i.d. and in more severe cases phenobarbitone sodium 2 gr. (0.12 G.) in 11 m. (0.7 ml.) of water should be injected subcutaneously. In maniacal chorea a mixture containing Pot. brom. 10 gr. (0.6 G.), chloral hydrat. 15 gr. (1 G.), syr. aurant. 30 m. (2 ml.), aquam ad $\frac{1}{2}$ fl. oz. (15 ml.), should be given t.d.s. for a child of 12. In some cases an injection of hyoscin, hydrobrom. 1/300 gr. (0.2 mg.) is of value. The results of the administration of ACTH or of cortisone are very variable. During the illness a careful watch should be kept on the heart to detect signs of dilatation, endocarditis or pericarditis. Should they occur, further rest in bed is required. Convalescence should never be hurried, and the child should not be allowed to return to school until all movements have ceased. No examinations should be allowed for a year after returning to school.

Huntington's Chorea

(Chronic Progressive Chorea)

Definition. A disease characterised by choreiform movements and mental deterioration.

Etiology. The cause is unknown. *Predisposing causes:* 1. Heredity: The disease presents a definite familial incidence, and in some cases the mental and physical characteristics are transmitted independently. The original patient went from Bures in Suffolk to America in 1650, and one line was traced through 30 generations up to 1932, 1,000 cases being noted. It was described by Huntington of Pomeroy, Ohio, in 1872. In successive generations the disease tends to show itself earlier; further,

A Mild Case: The twitching movements are seen chiefly on both sides of the face, and in one hand, arm or shoulder. Tremors are seen when the arm is extended and there is a tendency for the arm on the affected side to droop, with flexion of the wrist and over-extension of the metacarpo-phalangeal joints. The tongue may be jerked in and out when the patient is asked to protrude it. Jerky movements may occur at the elbow and shoulder when the patient grips the examiner's hand. The temperature is normal, but the heart may be slightly dilated.

A Moderate Case: The movements now are very obvious and the child is hardly ever still. The legs are less affected than the arms. When only two limbs are involved they are always homolateral. The face and trunk muscles are bilaterally affected. The movements are described as spontaneous, large and irregular. To a certain extent they can be controlled and they cease during sleep. The affected muscles are lacking in tone and the arm does not swing on the affected side on walking. Hypermetria is shown by the difficulty in grasping objects, and by the finger overshooting the mark in the finger-nose test. Dysdiadokokinesis may also be present. The reflexes: The cutaneous reflexes are normal. The deep reflexes are diminished in moderately severe cases, and the knee-jerks are "sustained," the leg being hung up for a brief period before it falls again. The sphincters are not affected. Sensation is normal. The temperature is often normal, unless the illness is complicated by an active carditis, and the pulse is not so rapid as in rheumatic fever.

Severe Cases (Chorea gravis): The movements are violent and the patient may be thrown from a chair or bed. There is disturbance of speech and of deglutition. Maniacal symptoms may appear, or there may be delirium with visual hallucinations. The temperature is usually raised and signs of endocarditis are rarely lacking. Other types described include: *Chorea mollis*, in which there is a flaccid paresis of the voluntary muscles, with only slight movements. *Paralytic chorea*, one arm or leg may be limp and almost useless.

The electro-encephalogram in chorea usually shows abnormalities. In hemichorea there are waves indicating electrical activity in the opposite cerebral cortex.

Differential Diagnosis. The diagnosis of a typical case of chorea usually presents few difficulties. Certain other conditions may require consideration, such as: 1. A tic. Here the movements are repetitive and limited to certain muscles. 2. Hysteria. St. Vitus' dance, as originally described, was presumably a hysterical manifestation. The movements in hysteria have not the character nor distribution of those in chorea. 3. Symptomatic chorea. This occurs in such diseases as epilepsy, infantile cerebral paralysis, tabes dorsalis, general paralysis of the insane, or as a post-encephalitic symptom. 4. Athetosis. The movements here differ from those of chorea and are usually confined to the hand or arm. They are generally the sequela of a hemiplegia. 5. Huntington's chorea. The age incidence is later, there is a familial history and usually mental degeneration.

Course and Complications. Mild cases respond to treatment in a

The earliest change noted by the parents is often an alteration in their child's disposition. The infant may become listless, or exhibit fits of temper characterised by screaming and biting. He may complain of itching, tingling or burning of the soles of the feet or palms of the hands. The appetite is often poor and thirst excessive, and micturition may be delayed.

On Examination: The child avoids the light and may lie curled up, or bury his head in the pillow, or sit forward with his head between his feet. The feet and hands are cold and the soles and palms resemble raw beef in their colour and sodden appearance. An erythematous rash may also be seen on the trunk and limbs in some cases. These skin changes do not always appear, and may not be noted until late in the disease. Gangrene of the fingers and toes occurs at times. The child may be seen rubbing his feet and hands or placing them on a cold surface or sucking his fingers. There may be profuse sweating, especially of the hands and feet. Muscular weakness and hypotonia with wasting may be a prominent feature, so that the child cannot walk. Myoclonic movements are sometimes seen. The teeth may also fall out. The deep reflexes are diminished. The inguinal, axillary and intercostal lymph nodes may be enlarged. Desquamation of the hands and feet occurs in the terminal stages of the disease, before the pink colour disappears. The temperature is usually normal, but a tachycardia of 140 to 180, persisting by day and night for several weeks, is often found. The blood pressure is usually raised to 110 or 130 mm. Hg. The white cells show a leucocytosis of 10,000 to 30,000 per c.mm. Lumbar puncture in the early febrile stage usually reveals a fluid showing meningitic changes with a slight excess of protein and cells. Insomnia may be a very pronounced feature of the disease.

Differential Diagnosis. The early stage is usually considered to be due to some slight febrile disorder. The excessive thirst may suggest diabetes insipidus, and the muscular weakness poliomyelitis, post-diphtheritic paralysis or amyotonia congenita. Several cases have been mistaken for tuberculous meningitis. The gangrene of the fingers or toes may suggest Morvan's disease.

Course and Complications. The disease may last for a few weeks up to six months, and may be interrupted by remissions or by exacerbations and relapses. Complications include septicæmia and bronchopneumonia.

Prognosis. This is usually good and there are no sequelæ. Progressive wasting or intercurrent infection causes death in about 5% of cases.

Treatment. Prophylactic: No teething powders containing mercury should be sold. This would probably stamp out the disease.

Curative: A soothing application for the hands and feet consists of a paste made of equal parts of Zinc oxide, calcium carbonate, glycerin and water. Some sedative drug, such as phenobarbitone $\frac{1}{2}$ gr. (7.5 mg.) for a baby of 4 months and $\frac{1}{2}$ gr. (30 mg.) for an infant of 4 years, should be prescribed for the insomnia.

if one generation escapes, the disease does not reappear. 2. Age: Usually between 30 and 50 years. 3. Sex: The incidence is equal.

Pathology. The brain is usually below the average size, with some atrophy of the frontal lobes and corpus striatum, the putamen is especially affected, with secondary involvement of the globus pallidus. The mental changes may be due to atrophy of the cortical nerve cells.

Clinical Findings. Choreic movements are first noticed in the face or in the muscles moving the head. The arms and legs are subsequently affected. The speech may have a peculiar explosive character. The oculo-motor muscles are usually the last to be involved. The patient finally becomes chair-ridden or bed-ridden. The mental changes are insidious, the patient is irritable and lacking in external interests, and gradually his higher mental faculties fail.

Differential Diagnosis. The character of the motor and mental changes, with a familial history, usually establishes the diagnosis. The blood and cerebrospinal fluid should be examined to exclude neurosyphilis. Senile chorea: The age of onset is later. There are choreic movements, but no mental changes. This may be an atypical form of Huntington's chorea. Congenital chorea: This is present from birth and is probably due to agenesis of the cells in the corpus striatum. There is no spasticity of the limbs, but the mental processes are rather slow. The condition appears to be related to Huntington's chorea. Apoplectic chorea: This results from a hæmorrhage into the substantia nigra in the mid-brain. The patient has choreiform movements and usually dies in a week or so.

Course and Complications. The course is usually slow, and the patient may live for 20 years or so after the first appearance of symptoms. Homicidal or suicidal mania may occur as a complication.

Prognosis. The disease, although not curable, is not necessarily fatal, and death is often due to an intercurrent infection.

Treatment. *Prophylactic.* Marriage should be avoided by a sufferer from the disease.

Curative. No drug is known to have any effect in checking its course.

Pink Disease

(*Infantile Acrodynia. Erythredema. Tropho-dermatoneurosis*)

Definition. A disease of infants characterised by mental disturbances, insomnia, sweating, disordered sensation of the extremities and peripheral vascular phenomena.

Etiology. There can be little doubt that the cause is mercury contained in teeth and dusting powders.

Pathology. Peripheral neuritic changes have been described together with chromatolysis of anterior horn cells, and at times round-celled infiltration of the brain.

Clinical Findings. *Prodromal Stage.* The onset is insidious, but there is probably an early stage with slight fever lasting a few days.

extension or radio-ulnar deviation at the wrist, or of pronation and supination of the forearm. Tremors also occur in the ankles and less frequently in the head and jaw. The tremors increase with emotion and can be controlled to a certain degree by voluntary use of the muscles. They cease during sleep except in advanced cases. It is not uncommon to find that the tremors vary inversely with the degree of muscular rigidity. There may also be cramps in the calf with plantar flexion of the toes, the big toe being hyperextended. Injection of 1% procaine into the motor point of a muscle will abolish the rigidity, but the tremors persist. The voice is monotonous and it may be high pitched. If the patient is watched when he is sitting it may be noticed that he remains quite still, apart from the tremors, for several hours. This is known as "poverty of movement." Trophic changes may be seen in the skin of the hands and feet, which appears smooth, glossy, red and cold. There may be marked sweating, at times unilateral. There is no evidence of a corticospinal tract lesion, thus the deep reflexes are not increased and the plantar response is flexor. Further the posterior columns of the spinal medulla (cord) and the higher sensory paths are intact, as shown by the absence of sensory changes. In the later stages the patient becomes bedridden, incontinent, and salivation may be troublesome.

Differential Diagnosis. There is little difficulty in recognising a typical case. At times the tremor is very slight, but there is then definite rigidity and the face is usually expressionless. The aching in the legs may be mistaken for intermittent claudication. In senile tremors the musculature is not rigid, and the expression is normal. The tremors have not the rhythmicity of paralysis agitans. The Parkinsonian syndrome following encephalitis lethargica can be differentiated by the history of a febrile illness some time previously. This may, however, have been of a slight nature, and have passed almost unnoticed. The age incidence, too, is usually much lower, and the rigidity is more marked than are the tremors. Salivation is common in post-encephalitic Parkinsonism, and oculogyric crises, tics and disturbances of sleep may occur. A Parkinsonian syndrome may also result from syphilis, and poisoning with phenothiazine, barbitone, manganese, carbon monoxide and carbon dioxide, or from cerebral arteriosclerosis in old people. In the latter variety the trunk and legs are chiefly affected and tremors are slight.

Course and Complications. The course is slowly progressive, all the voluntary muscles become unduly rigid, and the tremors tend to spread from limb to limb, the patient ultimately becomes bed-ridden, and is aptly described as a living statue, who cannot speak, read or write, but whose intelligence remains clear. Complications, such as urinary infections, bronchitis or bronchopneumonia, may develop, or a gradual failure of mental function may set in with a terminal coma.

Prognosis. The patient may live for 10 years or more after the onset of symptoms.

Treatment. The patient should be kept warm and in as good a general condition as possible. Hyoscine is used to alleviate the tremors.

Paralysis Agitans (*Parkinson's Disease*)

Definition. A disease characterised by muscular rigidity and tremors. It was described by James Parkinson in 1817 in his essay "*On the Shaking Palsy*."

Etiology. The cause is not known. *Predisposing causes:* 1. Age: Usually after 50. 2. Sex: Males predominate.

Pathology. The lesion is considered to lie in the extrapyramidal motor system of the brain, possibly, but not probably, resulting in some cases, especially in the elderly, from arteriocalillary fibrosis. The cells of the globus pallidus and to a lesser degree the substantia nigra are affected. These lesions produce rigidity and tremors resulting from abnormally discharging neurones.

Clinical Findings. The patient first notices some difficulty in performing actions with one hand, his writing may be very small, and he may be conscious of the muscles being somewhat stiff. He may also feel an aching pain in the arms or back, some general fatigue or perhaps sensations of heat or cold. After a variable time the tremors appear.

On Examination: An early case. Stiffness may be found in the muscles of one hand or forearm and the face may be rather expressionless. Slight tremors may be seen in one hand. The leg on the same side is often next affected. Later, the tremors spread to the other hand and the rigidity becomes generalised. *A developed case.* In the course of about two years the appearance of the patient is very striking. The face lacks expression, is vacant and somewhat staring and immobile (the Parkinsonian mask). The lower lip may twitch, but the eyelids seldom blink. The forehead is wrinkled or very smooth. The whole attitude is one of flexion, the neck and trunk are slightly flexed. The shoulders are slightly abducted, with the elbows flexed and held away from the body, the hands in front of the abdomen. The hands are held with the metacarpo-phalangeal joints flexed, and the interphalangeal joints extended and the thumb opposed to the index. The hips and knees are slightly flexed. The movements are all stiff and slow owing to general muscular rigidity. On looking to one side, the eyes move before the head, and the head and trunk move together. In walking the gait is shuffling, the steps are rather short, and the arms swing very little. Owing to the flexion of the trunk the balance is easily upset. If the patient catches his foot in an object on the floor, or if he is pushed from behind, he hurries forward with short steps as it were to overtake his centre of gravity. This is known as propulsion and the gait is festinant. Similarly, if the patient is pushed backwards or to one side (retropulsion or lateropulsion) he tends to fall down, and to prevent this has to move quickly in the direction in which he has been pushed. The tremors have a peculiar rhythmic character of about 4 to 7 vibrations a second. They are usually most marked in the fingers. The movements of the thumb and index finger produce a pill-rolling effect. There may also be movements of flexion and

involved the second side may be treated six months later. Contra-indications to operation are increasing mental confusion and rapidly advancing disease. Operation on patients over 65 years of age should only be done in unilateral disease and if the general condition is good. The best results are obtained in patients under 60 years. Severe tremors are an indication for operation.

Progressive Lenticular Degeneration

(Hepato-lenticular Degeneration. *Wilson's Disease*)

Definition. A progressive disease characterised by rhythmic tremors, muscular rigidity and cirrhosis of the liver.

Etiology. Hepato-lenticular degeneration is thought to be due to an abnormal metabolism of copper, a globulin necessary for its metabolism being absent. Copper is retained in the tissues, there is increased excretion of copper in the urine, and a low level of ceruloplasmin, which is the copper-binding alpha-globulin normally present in plasma. **Predisposing causes:** 1. Age: Children and young adults. The average age is 15 years. 2. Familial incidence: There is a tendency for the disease to occur in more than one member of a family.

Pathology. Bilateral degeneration occurs in the lentiform nucleus, especially in the putamen in which cavities may form. The extra-pyramidal motor tract, the striatorubral tract, is presumably deranged. Multilobular cirrhosis is seen in the liver. The copper content of the brain, liver and kidneys is increased. The pseudoscleroses of Westphal-Strümpell, and the torsion-spasms of Schälbe-Zichen are closely allied conditions.

Clinical Findings. In some cases a history suggestive of a previous disturbance of the liver is obtained, such as jaundice, with fever and vomiting.

On Examination: Muscular rigidity is found in the limbs and trunk, and bilateral tremors with involuntary movements are seen in the limbs. The tremors are increased by voluntary actions, but cease during sleep. The face may have an emotional expression, such as a spastic smile. The patient laughs or cries without adequate reason. Greenish-brown pigmentation (Kayser-Fleischer ring) may be seen at the edge of the cornea in some cases due to deposition of copper in Descemet's membrane. There is general muscular weakness and difficulty in balancing. Later, flexion contractures occur in the arms and legs, with generalised body wasting. In the terminal stages the legs may be extended, and both speech and swallowing are disturbed. There is no alteration in the cutaneous sensation, and the deep reflexes are normal. The liver is not usually palpable. The urine contains from 200 to 700 micrograms of copper in 24 hours, derived from the food. Normally the urine contains no copper. There is also an increased excretion of amino-acids in the urine. The serum copper-oxidase activity may be reduced before the first clinical signs appear.

Differential Diagnosis. The age incidence serves to distinguish the disease from paralysis agitans, and the facial expression also

It may be given by mouth as a tablet of hyoscine hydrobromide 1/200 gr. (0.3 mg.) to 1/50 gr. (1.2 mg.), 2 or 3 times a day, for several years. Alternatively hyoscin. hydrobrom. 1/100 gr. (0.6 mg.) may be injected once or twice daily or tnc. stramon. given in large doses by mouth. $\frac{3}{4}$ fl. oz. (22 ml.) of the tincture produces results comparable with an injection of 1/100 gr. (0.6 mg.) of hyoscine. If the stramonium produces dryness of the mouth or paralysis of accommodation, pilocarpine nitrate 1/10 gr. (6 mg.) can be added to one or more of the doses daily. Various other drugs have been employed.

Caramiphen hydrochlor. (Parpanit) is put up in 6.25 mg., 25 mg. and 50 mg. tablets. Its main effect is against rigidity. The initial dose is 12.5 mg. t.i.d., increasing to 12.5 mg. q.i.d., then 12.5 mg. 5 times a day. The first daily dose may then be increased to 25 mg., and subsequently the total daily dosage worked up to 125 mg., or more. Giddiness, weakness, and light-headedness may sometimes be provoked.

Diethazine hydrochlor. (Diparcol) is also useful in relieving rigidity. It is put up in 50 mg. and 250 mg. tablets. It may be used in doses of 50 mg. t.i.d., the dose being worked up to a total of 1 G. a day, i.e. 0.5 G. on waking, 0.25 G. at noon and 0.25 G. at 5 p.m. Side effects include nausea, vomiting, blurring of vision and drowsiness. Agranulocytosis may also occur.

Benzhexol (Artane) is useful in treating rigidity. It is put up in 2 mg. and 5 mg. tablets. The dose is 2 mg. the first day, increased by 2 mg. daily up to 9 mg. a day, divided into three doses. If nausea or blurring of vision occurs the drug should be discontinued for some days, and then a smaller dose given. Better results may be obtained if phenindamine tartrate (Thephorin) is simultaneously given in doses of 25 mg. tab., 2 to 8 daily. This drug seems most useful in post-encephalitic Parkinsonism.

Methixene hydrochlor. (Tremonil) 5 mg. tab., $\frac{1}{2}$ to 1 tab. t.d.s. may relieve tremors.

Ethopropazine (Lysivane) has some effect on tremors as well as on rigidity. It is put up in 50 mg. tablets. The dose is 50 mg. t.i.d. increased by 50 mg. daily to a total of 50 mg. 10 times a day. Side effects include drowsiness, vertigo, skin irritation, dryness of the mouth, and transient diplopia.

Diphenhydramine hydrochlor. (Benadryl) sometimes has a favourable effect. It is given in 50 mg. capsules 3 or 4 times a day. Somnolence can be combated by giving amphetamine sulph. 5 mg. mane. The muscles may be lightly massaged and passive movements employed to relieve rigidity. Aching is assuaged by aspirin 10 gr. (0.6 G.) as required. Sleep is secured by aspirin 10 to 15 gr. (0.6 to 1 G.), or phenobarbitone 1 gr. (60 mg.) or Soneryl $1\frac{1}{2}$ to 3 gr. (0.1 to 0.2 G.) nocte. In the terminal stages good nursing is essential.

Operation. A destructive lesion may be made by stereotaxic electrocoagulation of the ventro-lateral nucleus of the thalamus adjacent to the internal capsule and of a point in the globus pallidus or by ultrasonic rays focussed on these points. The contralateral side of the body is affected by the operation. If both sides of the body are

blurred or a portion of the visual field cut out. There may be a definite hemianopia. A bright spot may appear on the dark visual field, or there may be flashes of light or irregular objects with coloured outlines are seen, called fortification spectra (teichopsia). In some cases there is a sensory aura, with a feeling of numbness or tingling gradually travelling from the hand up the arm, usually on the side opposite to that on which the headache develops. It may spread to the lips and tongue on both sides. The headache gradually develops, often on the side opposite to that of the affected visual field. The pain, of a boring nature, often starts in the outer part of one eyeball and spreads over one side of the head and to the upper jaw, in the region of the molar teeth. It may be definitely throbbing in character, and almost intolerable when the patient is standing, but relieved by lying. The pain may spread to the shoulder. Sustained contractions of the muscles of the scalp and neck may occur, which are not relieved by ergotamine. It is aggravated by movement, noises or bright lights. Both sides of the head may be affected. The patient often feels sick, and may finally vomit, with relief to his pain. In some cases there is a temporary disturbance of speech, such as the use of wrong words.

On Examination: The patient usually looks ill and pale, but at times the face is flushed. The temperature is normal. The blood may show an eosinophilia of about 5 to 15%. Ophthalmoplegic migraine occurs in some cases, with paralysis of the III, IV or VI nerves on one side. The headache in these cases is usually very intense. This may last for a few days or weeks. This may be due to an intracranial aneurysm or neoplasm. Pressure on the carotid artery on one side may temporarily relieve the headache. In other cases a patient who is subject to migraine may experience weakness in one limb or one half of the body on waking, which gradually passes off during the day, without any headache developing. The 17-ketosteroids in the urine are increased during an attack.

Differential Diagnosis. The nature of the headache is usually diagnosed by the hemicrania and periodical recurrence. An occipital tumour may give rise to a clinical picture almost indistinguishable from migraine. In epilepsy the sensory aura is of much shorter duration than that met with in migraine. In histamine headache there is dilatation of the cerebral arteries, and an attack can be produced by the injection of histamine. There is usually no vomiting, but it is frequently associated with nasal mucosa congestion.

Course and Complications. The attacks usually last for a day, and the patient does not feel quite normal for another 2 or 3 days. They may recur once or twice a week, or only at intervals of months. Migraine may be followed later in life by epilepsy, or a migrainous subject may beget an epileptic.

Prognosis. The attacks usually cease after the age of 50. Loss of consciousness and death have been recorded in migraine.

Treatment. In mild cases a dose of aspirin 5 to 20 gr. (0.3 to 1.2 G.) will usually abort the attack. In more severe instances work is impossible, and the patient has to lie down in a dark and quiet room. Some

differentiates it from paralysis agitans or the Parkinsonian sequelæ of encephalitis lethargica.

Course and Complications. The course is variable, being either acute, subacute or chronic, the patient finally becoming bedridden. Ascites or hæmatemesis may occur.

Prognosis. The disease is fatal. Death occurs in a few weeks to a few years. Occasionally the patient may survive for 30 years.

Treatment. There is no cure known. It has been suggested that a course of injections of B.A.L. (dimercaprol) should be given intramuscularly, 1 ml. of a 10% solution in arachnis oil being injected once a week for a prolonged period. Calcium disodium versenate, 500 mg. tab., half a tablet before each meal, diminishes the absorption of copper and so is of value. D-penicillamine hydrochlor. may also be used to eliminate copper from the tissues, the average dose being 2 capsules, 150 mg. each, t.i.d. a.c. for varying periods up to a year or more. It should not be given if the patient is sensitive to penicillin.

Migraine

(Sick Headache)

Definition. Paroxysmal headache, usually hemicranial.

Etiology. The cause is not known. *Exciting causes:* 1. Worry. 2. Mental or physical strain. 3. Eyestrain. 4. Indigestion. 5. Menstruation. *Predisposing causes:* 1. Age: The attacks usually begin at puberty, and recur until after middle age. 2. Sex: Females predominate. The attacks are often associated with menstruation. 3. Personality. Sufferers from migraine are often conscientious, hard-working perfectionists. 4. Heredity. In some instances migraine runs in families. 5. Other illnesses.

Pathology. Various theories have been proposed to account for migraine. They include: 1. Cerebral changes. The visual disturbances which precede the headache are probably due to occipital cortical vascular spasm. The headache is due to dilatation of the extracerebral arteries of the dura and scalp, which are branches of the external carotid artery. Production of neurokinin, resulting in a sterile inflammatory reaction, or of serotonin causing lowering of the pain threshold at the site of the dilated arteries, has been suggested. Raising the cerebrospinal pressure up to 800 mm. H_2O does not diminish the headache, which indicates that the dural arteries are not affected. 2. Allergy. 3. Eyestrain. 4. Disturbance of liver function. 5. Intermittent hydrocephalus of one lateral ventricle due to temporary obstruction of the interventricular foramen. 6. Pituitary or ovarian disturbance. It is possible that the local vasodilator effect is connected with the presence of certain steroid compounds in the circulation. 7. A neurosis.

Clinical Findings. The patient often knows on waking that an attack will develop during the day. He has a feeling of malaise, with slight headache, mental dulness, depression, yawning, cold sensations or giddiness. In the course of a few hours, further premonitory symptoms may occur, such as disturbance of vision. The central vision may be

relieved by the injection of saline into the spinal subarachnoid space. This is called a *traction headache*. Bilateral compression of the jugular veins will increase headache. On the other hand increasing the intracranial pressure to a level of 550 mm. H₂O does not itself cause headache, which indicates that increased intracranial pressure does not of itself cause headache.

2. *Brain tumour headache*. This is usually intermittent in early cases. It is deep-seated, dull, and not throbbing. It is worse on coughing, and is not usually so severe as the headache of migraine or of meningitis. It is produced chiefly by traction on arteries, veins, venous sinuses or nerves. It is almost always present with posterior fossa tumours. It is located over the site of the tumour in about one-third of the cases. It is rarely occipital in supratentorial tumours unless there is papilloedema. When it is both occipital and frontal it is a sign of extensive cerebral displacement.

3. *Histamine headache*. The cluster headache syndrome. This is due to dilatation and stretching of pial and dural arteries. It can be produced by the intravenous or subcutaneous injection of histamine. The headache does not occur immediately after the injection when the arterial relaxation is maximal, but it is most marked when the blood pressure returns to its initial level. The large arteries at the base of the brain are chiefly responsible for this type of headache. It may occur in people with increased histamine sensitivity, and throbbing may be felt in arteries in other parts of the body, such as the chest wall. Pressure on the trunk, as by lying in bed or against a chair, may cause release of histamine.

4. *Fever headache*. There is increased pulsation of the cerebral arteries. Increasing the pressure of the fluid in the subarachnoid space lessens the headache.

5. *Migraine*. This has been described above.

6. *Headache associated with high blood pressure*. This is due to dilatation and distention of the branches of the external carotid artery, as in migraine. In some cases it is due to hypertensive encephalopathy. In cases of high blood pressure strain and fatigue may cause relaxation of the arteries and thus produce headache. The headache is not relieved by increasing the cerebrospinal fluid pressure. Ergotamine tartrate, which acts chiefly on the branches of the external carotid artery, relieves the headache. Pressure on the temporal, frontal, supraorbital, posterior auricular and occipital arteries diminishes the headache.

7. *Nasal and paranasal and mastoid headaches*. These are associated with sinus or mastoid disease. In sphenoidal and ethmoidal sinusitis the pain is felt between the eyes, at the back of the eyes and over the vertex. Frontal sinus headache often begins early in the morning and goes on all day, with maxillary antral disease the headache tends to begin in the afternoon. The headache is non-pulsatile.

8. *Ocular headache*. This may be due to errors of refraction, errors of muscle balance or glaucoma. Myopia does not cause headache because the myope does not contract his eye muscles, as this would make his vision worse. Electromyograms show abnormalities of the scalp muscles in ocular headaches.

patients obtain relief from phenacetin 10 gr. (0.6 G.) and caffein citrate 5 gr. (0.3 G.), repeated in an hour, if necessary. It is better to avoid the regular use of bromides, but if the attacks are very frequent and disabling, the use of phenobarbitone $\frac{1}{2}$ to 1 gr. (30 to 60 mg.) every night may hold them in control. Ergotamine tartrate, owing to its vasoconstrictor effect on the branches of the external carotid artery, will in the majority of cases stop the headache quickly. Ergotamine tartrate is a potentially dangerous drug. The recognised contraindications to its use are peripheral vascular disease, hypertension, coronary disease, pregnancy, thyrotoxicosis, gross sepsis, hepatic and renal disease, and anæmia. In addition, an individual who shows none of these recognised contraindications may be sensitive to small doses of ergotamine. Thus 7 mg. of ergotamine tartrate, taken over a period of 2 and $\frac{1}{3}$ days produced gangrene of the extremities necessitating amputation of both legs, the right thumb, and the tip of the right index finger. It seems doubtful, therefore, whether it is justifiable to prescribe ergotamine for the treatment of migraine. As much as 10 mg. of ergotamine tartrate is recommended as the dose during the first day's treatment. If it is decided to give ergotamine, the minimum safe effective dose must be worked out, beginning with 1 mg. in the first instance. Ergotamine may be given by inhalation, 0.36 mg. with each puff from a "Medihaler." Nitroglycerin has a reputation for diminishing the frequency of the attacks, and may be given as the tabella glyceryl. trinitrat. 1/180 gr. (0.5 mg.) t.d.s., or as Gowers' mixture: Liq. trinitrin. 1 m. (0.06 ml.), liq. strychnin. hydrochlor. 5 m. (0.3 ml.), sod. brom. 10 gr. (0.6 G.), acid. hydrobrom. dil. 10 m. (0.6 ml.), tnc. gelsemii 5 m. (0.3 ml.), aq. chlorof. ad $\frac{1}{2}$ fl. oz. (15 ml.). $\frac{1}{2}$ fl. oz. (15 ml.) ex aqua t.d.s. Between the attacks the patient should sedulously avoid constipation, fats should be restricted in the majority of cases, and any ocular refractive error or muscular imbalance should be corrected. Methysergide, a serotonin antagonist, has been found helpful as a prophylactic in some cases, in doses of 1 to 8 mg. daily. It may cause disturbances of equilibrium, and must not be given in suspected vascular disease, pregnancy, œdematous states, liver or kidney failure, or in malnutrition.

Headache

Recurrent headache is a very common minor malady, although in some cases it proves extremely disabling and in others is a symptom of grave disease.

Etiology. Intracranial causes of headache include: 1. Traction on veins passing to the venous sinuses or displacement of the sinuses. 2. Traction on the middle meningeal arteries. 3. Traction on the larger arteries at the base of the brain. 4. Distention and dilatation of the intracranial arteries. 5. Inflammation around pain-sensitive structures of the head. 6. Pressure by tumours on cranial and cervical nerves.

Pain may be referred to the head in angina pectoris.

Varieties of Headache. 1. *Due to changes in intracranial pressure*, either above or below the normal. Removal of 20 ml. of spinal fluid with the patient in the erect position will cause headache which can be

his mouth or eyebrow. He may constantly turn his head, shrug his shoulder, cough or sniff. The same tic is repeated at short intervals, and is likely to be more pronounced if the patient is nervous.

2. *Co-ordinated and convulsive tics.* The movements are more complicated, thus the patient may repeatedly make stooping movements as he walks along, or he may have attacks of convulsive movements accompanied by explosive words, such as swearing (coprolalia), or words or actions may be repeated or copied (echolalia and echokinesis).

3. *Psychical tics.* The patient is the victim of various obsessions. Thus when walking he feels he must touch each lamp-post he passes, and if he misses one, he goes back and touches it.

Differential Diagnosis. The brisk nature of the repetitive muscular contractions usually renders the diagnosis of a tic clear. In some cases the movements which occur in chorea, focal epilepsy, torsion spasm, or in encephalitis lethargica, may require consideration.

Course and Complications. Tics usually continue without change. A psychical tic may prove so distressing as ultimately to lead to insanity or suicide.

Prognosis. The chance of a tic disappearing is less if it has persisted for a long time or if it begins after middle age.

Treatment. Any reflex source of irritation should be removed. The general health should be improved as far as possible by proper exercise, and a sufficiency of fresh air and food. Parents should not direct attention to the tic, as, although this may lead to the disappearance of one tic, it is usually attended by the development of a fresh one. An endeavour should be made 2 or 3 times a day to relax the muscles affected, the patient lying down and concentrating his attention on keeping the muscles still. Further, exercises should be performed in which the affected muscles are contracted and relaxed systematically. In some cases hypnotic suggestion has been attended with success.

Professional Cramp

(Occupational Neurosis)

Definition. Fatigue and cramp affecting groups of muscles employed in skilled occupations.

Etiology. The cramp occurs as the result of prolonged use of certain muscles, associated with a neuropathic tendency.

Pathology. The fatigue process is believed to occur, not in the muscles or in the peripheral nerves, but centrally in the brain.

Clinical Findings. Many varieties are described, such as writer's cramp, musician's, telegraphist's, typist's, haircutter's, and cigarette-maker's cramp. The patient is usually a male between the ages of 20 and 50, and a skilled worker who is performing his specialised task. In the early stages there is aching or stiffness in the muscles, and if the worker persists, he may have to stop owing either to definite weakness or cramp of the muscles. After a short rest and rubbing the muscles,

9. *Cervical headache.* This variety of pain is known as *tension headache*. Tender spots may be felt in the occipital muscles. Anxiety is a common cause. The patient may have pain, a feeling of pressure or paræsthesia on the vertex. Contraction of the scalp, head and neck muscles is often present. In some cases the headache is due to loss of the normal lordotic curvature of the cervical spine, due to a sprain of the ligaments.

This type of headache is best treated by rest in bed, massage and heat applied to the neck. The patient should be reassured there is no serious disease, such as a cerebral tumour, and aspirin 10 gr. (0.6 G.) should be given 3 or 4 times a day, together with phenobarbitone $\frac{1}{2}$ gr. (30 mg.) morning and evening. In some cases stretching of the neck muscles is beneficial.

10. *Headache due to general diseases.* The most important amongst these are chronic nephritis, anæmia and syphilis. Strychnine and possibly iron may be causes of headache.

Clinical Notes. Certain clinical observations are of value in diagnosing the variety of headache. The most common causes are migraine and emotional tension. The most severe headache is due to subarachnoid hæmorrhage and meningitis. Intracerebral hæmorrhage rarely causes headache unless the blood escapes into the ventricles or subarachnoid space. Headache usually becomes severe in the terminal phases of cerebral tumour before the stage of coma. Pulsating headaches are met with in migraine, fever, high blood pressure, histamine sensitivity and hæmangiomas. A continuous ache is characteristic of a cerebral tumour in the later stages. A feeling of a tight band round the head or of a tight cap, is due to muscle spasm associated with eye causes, sinus infection and emotions. If the headache is always on the same side there may be an aneurysm of the circulus arteriosus (of Willis). A bitemporal headache is met with in pituitary adenoma.

Obsessive-Compulsive Neurosis

(Tics. Habit Spasms)

Definition. Repetitive purposive movements, originally performed in response to a mental or physical stimulus, which tend to persist after the exciting cause has been removed.

Etiology. In a few cases an external physical cause has existed, such as conjunctivitis or a frayed stiff collar. In the majority of instances, however, no such cause can be traced. There is a neuropathic tendency which leads to the perpetuation of the tic. *Predisposing causes:* 1. Age: The tic often starts about puberty, but it may begin earlier or later. 2. Sex: The incidence is equal.

Pathology. No organic lesion of the nervous system can be found. A tic may be regarded as a conditioned reflex, the stimulus being an associated psychological one.

Clinical Findings. Certain varieties of tic are described, such as: 1. *Simple tic.* Here only individual muscles or a few muscles are involved. Thus the patient blinks frequently when talking, or twitches

but the patient is not really unconscious, she does not bite her tongue, or micturate, and the corneal reflexes persist. *Major attacks (grande hystérie)*: This is very uncommon in England, but was met with chiefly in France at the end of the last century. The attack may last for several hours. The early stages are characterised by clonic and tonic muscular contractions. The patient may scream and assume various contortional and emotional attitudes. On recovery, visual and auditory hallucinations may persist for a time. The attacks occur in the presence of others, and probably are largely due to suggestion. Somnambulism is considered to be a manifestation of major hysteria. (b) *Non-convulsive motor hysteria*. The patient may complain of inability to move an arm or leg, or the arm and leg on the same side of the body, or both legs.

On Examination: Various types of motor hysteria may be seen, such as a monoplegia, hemiplegia or paraplegia. Further, there may be contractures, irregular movements or catalepsy. In the hysterical paralysis certain distinguishing features can usually be detected. Thus a patient may say she cannot stand or walk (astasia abasia) and yet she can move her legs perfectly when lying down. The muscles do not waste, the electrical reactions are normal, and the deep reflexes are often exaggerated. The plantar response is flexor in type. If a patient is asked to bend a paralysed arm, the antagonistic muscles can often be felt to contract, opposing any flexion result which would be produced by contraction of the agonists. In a hysterical paralysis of a leg, if the patient is asked to raise her body when lying with her arms across her chest, the sound leg will come up in the air, but the paralysed one remains on the bed. This is due to muscular contraction in the paralysed leg, and is the reverse of that which takes place in an organic monoplegia, where the paralysed leg rises higher than the sound one. Further, in hysterical monoplegia, sensory cutaneous loss of a hysterical type is generally present. The gait differs from that of an organic lesion, in that the "paralysed" leg tends to be drawn along after the body, and is not swung outwards as in an organic lesion. The adductor muscles of the vocal cords may be affected. *Spasmodic contractions*. Various muscles of the trunk, limbs or face, may be involved. Thus there may be trismus, or ptosis due to contracture of the orbicularis oculi, without compensatory wrinkling of the forehead. The contraction does not usually cease during sleep, but is abolished by anæsthesia. The phantom abdominal tumour is of this nature, there being spasms of the abdominal muscles in localised areas, with some flatulent distension. *Irregular movements*. These consist of tremors, muscular twitchings, and choreiform or repetitive movements. Various complicated actions, such as bowing, may be repeatedly performed. There may be attacks of laughing or crying. In *catalepsy* the patient goes into a trance, the limbs are rigid, and remain in whatever position they are placed.

2. *Sensory Types*. The patient may complain of every imaginable type of pain. There may be headache like a nail being driven into the skull (clavus hystericus), defective vision, such as mistiness, inability to bear a bright light, or blindness in one eye. The patient may complain of deafness or increased sensitivity to sounds. Other

he is able to resume. If, however, he endeavours to persist in his occupation, the disability becomes more marked, and finally it is impossible for him to carry on.

Differential Diagnosis. Every case should be carefully examined to exclude such lesions as peripheral neuritis, tenosynovitis, or an early stage of paralysis agitans. The diagnosis is usually clear, as certain groups of muscles are affected, and only when a definite act is performed.

Course and Complications. The course is progressive, as described above.

Prognosis. The outlook is unfavourable unless adequate treatment is given, and even then relapse is liable to occur.

Treatment. A rest of at least 6 months from the provocative occupation is required. In writer's cramp the patient should learn to use a large penholder; he should not grip it tightly, and he should write from the shoulder rather than from the fingers and wrists.

Hysteria

Definition. A condition characterised by mental dissociation which may lead to somatic symptoms, sensory disturbances, to personality changes or amnesia, without any organic disease of the nervous system being present.

Etiology. The true cause of hysteria remains unknown. It is believed by some that there is a restriction of the fields of consciousness, and that the symptoms develop so that the patient may escape from the realities of mental emotions or physical hardships. They result, therefore, either from auto- or hetero-suggestion. The Freudian school consider that hysteria is due to a repression of conflicts, usually of a sexual nature. Hysteria may follow a severe mental or physical shock, or be due to suggestion, especially in epidemics of hysteria. It may be purposive, a method of avoiding an unpleasant duty, or a reaction to neglect or mental suffering. *Predisposing causes:* 1. Age: Usually between 15 and 35 years. 2. Sex: Females predominate. 3. Heredity: A neuropathic tendency is an important factor. 4. Race: In Europe the Teutonic races are comparatively immune, the Latins, Slavs and Jews being susceptible.

Pathology. No organic lesion is found in the brain.

Clinical Findings. The patient is usually an adult woman, lacking emotional control and introspective. She is not worried about her symptoms, and may be mentally dull. The clinical picture varies according to the type of hysteria present.

1. *Motor Types.* (a) *Convulsive hysteria.* This occurs in attacks, and is sometimes known as hysterio-epilepsy. *Minor attacks:* The patient may have preliminary disturbances such as palpitations, the feeling of a lump rising in the throat (globus hystericus) or distressed breathing. She then falls in the presence of onlookers, but is careful not to injure herself. Various clonic muscular contractions take place,

Treatment. In some cases a convulsive attack may be arrested by firm pressure on a so-called hysterofrenic spot, such as the supra-orbital notch. The most hopeful method of cure is by persuasion. The physician must acquire the complete confidence of his patient, who is made to believe that a cure is possible, and will be effected. The nature of the complaint is explained to the patient. In some cases the use of electrical stimulation is of value in abolishing cutaneous anæsthesia or in demonstrating to the patient that his muscles will contract.

Neurasthenia

(*Anxiety States*)

Definition. A condition characterised by abnormal fatigue of the mind or body without a discoverable organic cause.

Etiology. No definite cause can be assigned to neurasthenia; it is sometimes considered to be a fatigue neurosis. Pavlov produced experimental neurosis in dogs as the result of overtaxing inhibition processes by conditioned reflexes. *Exciting causes:* 1. Overwork. 2. Worry. 3. Illness, such as influenza, anæmia or typhoid fever. 4. Drugs, such as alcohol or cocaine. 5. Injury, producing traumatic neurasthenia. *Predisposing causes:* 1. An inherited neuropathic tendency. 2. Age: Usually between 20 and 45 years. 3. Sex: Males predominate.

The Freudian school believes that neurasthenia is due to some sexual trauma, which may only be made manifest when one of the exciting causes is operative.

Clinical Findings. The patient is usually an adult of lugubrious expression and with many complaints, although in some cases he looks extremely fit. In order to avoid forgetting any symptom he may bring a list of them written out. The examiner usually finds that the list is not easily exhausted, and when asked if there is anything else that he has noticed wrong, the patient will produce another complaint. In neurasthenia bodily complaints predominate, whereas in psychasthenia the symptoms are chiefly mental. The onset is usually gradual, the patient feeling tired and lacking interest in anything except himself. The fatigue is abnormal, the patient wakes feeling tired, but often improves as the day goes on. The symptoms in neurasthenia may be referred to the various systems of the body. The patient may complain of loss of appetite, flatulent dyspepsia, or of occipital headache. He often states that there is a feeling of oppression on the top of the head or of constriction of the head. The skull may feel empty or too full. He may suffer from palpitations, dizziness, flushing, sweating, a frequent desire to yawn, a sensation of a lump in the throat, numbness or tingling in various parts of the body. Backache may be marked and sexual disturbances, such as impotence, a prominent symptom. In psychasthenia the patient may have groundless fears. Certain of these have been granted names, such as fear of open spaces (*agoraphobia*), of closed

symptoms include deficiency of taste (often bilateral) or of smell, a lump in the throat, loss of appetite, flatulent dyspepsia, constipation, retention of urine, yawning, hiccough, coughing, inability to take a full breath, palpitations, sweating, or flushing. *Psychical types* include cases of dual personality and amnesia. The patient is reported as "missing and probably suffering from loss of memory."

On Examination: In hysterical blindness of one eye, the patient may be seen to blink when a blow is directed at the affected eye, the other being covered. In hysterical deafness, the patient may be awakened by a noise of average intensity. Certain hysterical stigmata may be found, the most important being cutaneous and pharyngeal anæsthesia, and restriction of the visual fields. The patient is unaware of these stigmata, and some authorities maintain they result from suggestion on the part of the examiner. This is doubtful; they are more probably due to auto-suggestion. *Cutaneous anæsthesia.* The patient does not injure the anæsthetic part. There may be hemianæsthesia, or a sock, stocking, glove or sleeve anæsthesia in a limb. The upper limits of anæsthesia are fairly sharply defined. Joint sense is unaffected. The patient may really feel when the skin is stimulated, as is shown by asking her to say "yes" when the skin is pricked, and "no" when it is not pricked. She may fall into the trap and say "no" when the pin is applied to the "anæsthetic" area. A stimulus applied to one limb may be referred to a corresponding spot on the other limb (allocheiria). Areas of hyperæsthesia may be found on the chest or abdomen, and so-called hysterogenous spots. These are tender spots, especially likely to be present in the left inguinal region. Pressure on them may induce a hysterical fit. *Reflexes.* The conjunctival, abdominal and plantar reflexes may be lost in cases of cutaneous anæsthesia. The pharyngeal reflex is not necessarily lost in hysteria if care is taken to avoid suggestion. *Restriction of the visual fields.* The patient does not complain of loss of vision in any direction before perimetric tests are carried out. The spiral restriction of the visual field, as determined by the perimeter, appears to be the result of suggestion.

Differential Diagnosis. Convulsive hysteria is differentiated from epilepsy by the points mentioned on p. 852. In many cases the diagnosis of hysteria presents no difficulties, when the characteristic findings described above are considered. It should always be remembered that a hysterical element may be implanted on an organic lesion, and may persist when the organic lesion is healed or arrested. In every case a complete examination should be carried out, not once only, but at intervals of several weeks. In this manner the early stages of an organic disease, such as multiple sclerosis, will not be overlooked. In malingering there is a deliberate attempt to deceive, which is not the case in hysteria.

Course and Complications. Hysterical symptoms may persist for many years or disappear suddenly at any time. There is always a tendency for the cure to be temporary and for subsequent recurrence.

Prognosis. "Miraculous" cures may result from suggestion, the blind recovering his sight or the mute his power of speech.

THE CEREBELLUM

Anatomy and Physiology

The cerebellum is composed of three parts, a central vermis and two hemispheres. The vermis contains the following nuclei: The nucleus fastigii and the nucleus globosus on each side. Each hemisphere contains the dentate nucleus and the nucleus emboliformis. The cerebellum is connected with the brain by three peduncles on each side, the inferior peduncle, the middle peduncle and the superior peduncle (see Fig. 84, p. 380).

Developmentally the cerebellum consists of two parts separated by the posterolateral fissure. These are the flocculonodular lobe with afferent and efferent vestibular connections, equilibratory in function, and the corpus cerebelli which integrates proprioceptive impulses from muscles. The corpus cerebelli is divided by the fissura prima into an anterior and posterior lobe. The anterior lobe consists anatomically of

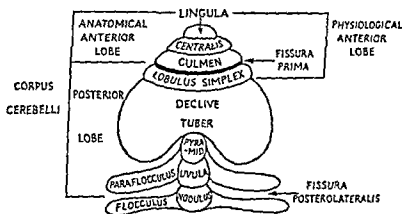


FIG. 85. DIAGRAM OF THE CEREBELLAR CORTEX SHOWING PRINCIPAL DIVISIONS. (After Dow and Fulton.)

the lingula, lobus centralis and culmen. Physiologically the lobulus simplex belongs to the anterior lobe. The anterior lobe controls postural reflexes and the synergies of walking. The posterior lobe is formed anatomically of the lobulus simplex, declive, tuber, pyramid and uvula. This lobe controls ipsilateral skilled voluntary movements.

The paleocerebellum consists of the flocculonodular lobe, the anterior lobe of the corpus cerebelli, the uvula and pyramid. The neocerebellum is formed by the greater part of the hemispheres and the vermis (see Fig. 85). Ablation of the nodulus in dogs affords complete protection against motion sickness.

The Efferent Tracts. There are three main efferent tracts from the cerebellum.

1. *The Cerebello-rubrospinal Tract.* From the cortex of the hemisphere through the superior peduncle to the opposite red nucleus. The second relay of fibres conducts the impulses down the rubrospinal tract which crosses at its origin so that it runs down to the anterior horn cells on the same side of the body as that from which the impulses arose in

spaces (claustrophobia), of disease (pathophobia), of crowds (anthropophobia), of solitude (monophobia), of heights (acrophobia), and of dirt (mysophobia). The patient feels unable to concentrate, to read or to keep still. He has needless worries and suffers from insomnia. He may be the victim of various obsessions, a prey to drink (dipsomania), to drugs (toxicomania), or to stealing (kleptomania).

On Examination: The patient often looks anxious, but the nutrition is usually good. The peripheral circulation may be poor and the hands cold and bluish. There are no signs of organic disease discoverable, but the deep reflexes are brisk. In the cases of flatulent dyspepsia the patient may make loud eructations the whole time that he is being examined. The blood pressure in neurasthenia is usually low, and the pulse rate unstable, varying more than 10 beats in the standing and recumbent position. Traumatic neurasthenia follows some accidental injury, such as a railway accident when often no external injury is visible. Railway spine may then develop, with pain in the back and weakness, although no organic lesion is discoverable by X-ray or other examination.

Differential Diagnosis. Every care should be taken to exclude organic disease before a diagnosis of neurasthenia is made. Thus early pulmonary tuberculosis is at times diagnosed as neurasthenia, a mistake which would not occur if the morning and evening temperatures were taken, and the chest carefully examined physically and radiographically. A cerebral tumour in a silent area of the brain may also cause disturbance of health with vague sensations of distress and pain, without any localising signs being found. Later, with increasing intracranial pressure, the diagnosis becomes apparent. General paralysis of the insane at its onset may be mistaken for neurasthenia. If there is doubt, the blood and cerebrospinal fluid should be examined. An early case of Addison's disease may also be diagnosed as neurasthenia, a blood pressure as low as 100 mm. Hg. systolic should suggest the former diagnosis.

Course and Complications. Neurasthenia is a chronic condition, which is liable to persist unless adequately treated. Insanity is a rare complication.

Prognosis. The outlook is fairly good, but, despite treatment, the neuropathic disposition remains and relapses are not infrequent.

Treatment. The most important factor in successful treatment is the discovery and elimination of the exciting cause, whether it is due to physical strain, mental worry, toxæmia or trauma. In severe cases a complete rest, change of environment, and a congenial occupation are required. Apart from this the treatment is general, such as extra diet in the form of a glass of milk or cup of cocoa in the morning, some exercise daily out of doors, and early hours at night. If there is difficulty in sleeping, a dose of phenobarbitone 1 to 2 gr. (60 to 120 mg.) should be given at night. In traumatic neurasthenia an improvement is often noted when the responsibility for treatment is definitely cast upon the patient, by settlement of any compensation claim.

the conjugate deviation of the head and eyes, phonation and articulation.

Lesions of the Cerebellum

The following lesions may occur: 1. *Hypoplasia*. This is a congenital lesion. The cerebellum may be partly or completely absent.

2. *Primary Progressive Degeneration* (Sanger-Brown ataxia, see p. 446). The fibres running from the cortex to the nuclei are affected.

3. *Olivoponto-cerebellar Atrophy*. There is atrophy of the cortex, middle peduncles and part of the inferior peduncles. The inferior olives are also affected.

4. *Vascular Lesions*. Thrombosis is liable to affect the posterior inferior cerebellar artery. Hæmorrhage may occur from the superior cerebellar artery.

5. *Tumours*. These include a glioma, endothelioma, sarcoma, psammoma, lipoma, myxoma and cholesteatoma. The medulloblastoma of childhood arises in the flocculonodular lobe in embryonal rests. It is a relatively common tumour. The cystic angioma of the cerebellum may be associated with an angiomatous retinal tumour (v. Hippel's disease). Multiple angiomatous tumours may also occur in the cord, kidney, liver, spleen and pancreas (Lindau's disease). Degenerative cysts also occur, they are generally gliomatous or sarcomatous.

6. *Granulomata*. A tuberculoma or gumma may be found.

7. *Abscess*. This may be secondary to suppuration in the mastoid or labyrinth, or to spread of infection from transverse sinus thrombosis. The infection may be blood-borne, as in bronchiectasis or bacterial endocarditis. In some cases the abscess results from a wound of the cerebellum, which may have been inflicted some time before.

8. *Multiple Sclerosis*.

9. *Cortical Cerebellar Atrophy*.

The most commonly occurring lesions are a glioma and a tuberculoma.

Clinical Findings. The results of cerebellar lesions vary according to whether they are irritative or paralytic, and also whether the hemisphere or vermis is affected. Neighbouring structures may also be involved, such as the cranial nerves, especially the VIII, VI and V, and the pons with disturbances of either the motor or sensory tracts.

Irritative lesions. These result usually from a wound or hæmorrhage.

Paralytic lesions. These may be due to thrombosis, a tumour or an abscess.

Cerebellar Hæmorrhage

The patient complains of very severe vertigo. He feels as if his body is being rotated away from the side of the lesion, and as if surrounding objects are also rotating in the same direction. There may also be pain in the occipital region with vomiting, and the patient often falls to the ground, his body being rotated on its long axis by "forced movements."

the cerebellum. The final relay is by the ventral nerve roots to the skeletal muscles.

2. *The Cerebello-cerebral Tract.* From the cerebellar cortex to the dentate nucleus where the second relay passes through the superior cerebellar peduncle to the thalamus of the opposite side. The final relay conducts the impulses to the frontal and post-central cerebral cortex.

3. *The Cerebello-Vestibular Tract.* From the cerebellar cortex through the inferior peduncle to the lateral vestibular (Deiters) nucleus of the same and opposite sides. Relays of fibres connect thence with the vestibulospinal tract running down to the anterior horn cells on the same side, and so by the final relay to the skeletal muscles, and by the medial longitudinal bundle with the III, IV and VI nuclei regulating eye movements and with the nuclei of the spinal portion of the XI nerve controlling head movements.

The Afferent Tracts. There are six main tracts.

1. *The Posterior Spinocerebellar Tract.* This runs through the inferior peduncle to the vermis on the same side. The final relay carries the impulses to the cerebellar cortex of the hemisphere of the same side.

2. *The Anterior Spinocerebellar Tract.* This runs up the opposite side of the cord, and ascends to the level of the red nucleus. It turns down and crosses the mid-line to the superior cerebellar peduncle, and so passes to the vermis. The final relay carries the impulses to the cerebellar cortex of the hemisphere on the side at which the impulses entered the spinal cord.

3. *Fibres arising from the Cuneate and Gracile Nuclei.* These form the arcuate fibres, and pass through the inferior peduncle to the vermis. The final relay is to the cortex of the hemisphere of the cerebellum, on the same side as that on which the majority of impulses entered the cord.

4. *The Olivo-cerebellar Tract.* Fibres pass from the inferior olive in the medulla oblongata, cross the mid-line, and enter the cerebellum by the inferior peduncle. They relay in the vermis, the final path being to the cerebellar cortex of the hemisphere on the opposite side.

5. *The Vestibulo-cerebellar Tract.* Fibres run from the lateral vestibular nucleus through the inferior peduncle to the homolateral nucleus fastigii of the vermis. A second relay conveys the impulses to the cerebellar cortex of the hemisphere of the same side.

6. *The Cerebro-cerebellar Tract.* Fibres pass from the frontal, temporal and occipital lobes to the pons. A second relay conveys the impulses by the middle peduncle to the vermis. The final relay runs to the cerebellar cortex of the opposite hemisphere.

The cerebellum is thus intimately connected with the skeletal muscles on both sides, with the impulses from the lateral vestibular nucleus concerned with equilibrium, and with the co-ordination of the eye and head movements.

The chief function of the cerebellum is to enforce and control the postural tone of the skeletal muscles, which is of vital importance for synergic or co-ordinated movements. The hemispheres are chiefly concerned with the tone of muscles on the same side of the body, and the vermis with the backward or forward balance of the body and with

cases there is a tendency on standing to fall backwards or to one side. Cerebellar ataxia is not increased on closing the eyes. Ataxia of speech occurs especially in vermis lesions, the speech being either staccato or drunken.

4. *Gait*. This is reeling or drunken, the patient tending to deviate or fall to the affected side. There is difficulty in standing on the leg on the affected side. On walking also the affected leg swings outwards, the patient tending to walk round it as if it were a crutch. The arm on the affected side often remains motionless. *Attitude*. The occiput may be pointing towards the shoulder on the affected side, which is usually slightly lower than, and in front of, the opposite shoulder; there is some scoliosis with concavity towards the side of the lesion.

5. *The Rebound Phenomenon*. The patient holds his arms flexed, and the examiner pulls against them. On releasing the pull on the arm on the affected side, the patient's hand flies back to hit his face or body, whereas this movement is automatically checked on the sound side.

6. *Dysidiadokokinesis*. The patient is unable to perform rapid alternate actions on the affected side, such as pronation and supination of the forearm, or closing and unclosing the hand.

7. *Nystagmus*. This occurs typically as a fixation nystagmus, which is not present when the eyes are at rest. If the patient is asked to look to the affected side, nystagmus appears, the eyes slowly swinging away from the fixation position owing to lack of tone in the muscles, and being rapidly jerked back again. If the patient looks to the sound side, the nystagmus consists of smaller movements which are more rapid and irregular, but there is a slow movement away from the fixation position and a rapid jerk back. With bilateral lesions nystagmus occurs on looking to either side, the slow movement being away from the fixation point and the quick movement towards it. Vertical nystagmus may occur with lesions of the vermis. Nystagmus may also be provoked by caloric stimulation of the ears. Further, if the stimulation produces conjugate deviation of the eyes, the lesion is also probably central. There is also often difficulty in looking towards the side of the lesion.

8. *Vertigo*. This may persist, the patient feeling that both he and the surrounding objects are rotating away from the side of the lesion.

9. *The Knee-jerks*. The knee on the side of the lesion shows a pendulum swing due to lack of tone in the extensors.

10. *Tremors*. Intention tremor may occur in the homolateral limbs. If the arms are held out static tremors may be seen on the affected side, the hand dropping a little and then being jerked upwards.

11. *Cerebellar Catalepsy*. This term is applied to the abnormal steadiness which may at first be seen in the homolateral arm or leg when it is held out, before the static tremor develops.

Cerebellar Thrombosis

Clinical Findings. Thrombosis of the posterior inferior cerebellar artery is known as the Wallenberg syndrome. There is usually a

On Examination: The patient is often found lying with the side of his face, corresponding with the site of the lesion, on the pillow. Spontaneous nystagmus may be seen, with slow movements away from the side of the lesion and sharp short movements in the opposite direction. There may also be skew deviation of the eyes, the eye on the affected side looking downwards and inwards, and the other eye upwards and outwards. In many cases a hæmorrhage involves the lateral region of the medulla oblongata. When the spinothalamic tract is affected, there is analgesia for pain and temperature sensations on the same side of the face and head and on the opposite side of the body and limbs. Involvement of the nucleus ambiguus may result in interference with swallowing and speech. An irritative lesion may cause a cerebellar fit, characterised by a sudden onset, with loss of consciousness, and tonic spasm. The head is retracted and the back arched. The elbows, hips, knees and ankles are extended. The patient does not usually bite his tongue, or micturate. With unilateral lesions the homolateral leg is adducted and the heterolateral leg abducted. The patient rotates to the side of the lesion, and the eyes deviate to the opposite side.

The Cerebellar-syndrome

Special signs and symptoms are described which constitute the "cerebellar-syndrome." These signs cannot be detected in every case, and are obscured if the lesion presses on the medulla oblongata and interferes with the corticospinal tracts. The chief features of the cerebellar-syndrome are as follows: 1. *Hypotonia*. The muscles of the body on the same side as the lesion are affected. This may be demonstrated when the patient is lying down by the extent to which the patella can be depressed on the two sides when the muscles are relaxed. The leg can also be abducted farther on the affected side. The arm is more flail-like if the forearm is shaken up and down by grasping the upper arm. In the past-pointing test the arm on the affected side deviates away from the object.

2. *Asthenia*. The grip is less powerful on the affected side, and the limb will tire suddenly and completely.

3. *Ataxia*. This can be shown in various ways. Thus there is asynergia or decomposition of movements. The muscles do not work together smoothly in performing such an action as putting the foot on a chair. Astasia consists in jerky clonic contractions of muscles, and can be tested by feeling the biceps while the patient flexes his forearm with his elbow resting on a table. Dysmetria (disturbance of the range of movement). Movements are often performed excessively (hypermetria). Thus there is a tendency to overshoot the mark in the finger-nose test, and in taking up a glass the hand opens too widely when seizing it and when putting it down. There may also be delay in relaxation of muscles, so that the glass is knocked over when the patient takes his hand away from it. Associated movements: Irregular clonic movements may occur in the homolateral limb when forced muscular contractions are made in the limb on the sound side. In some

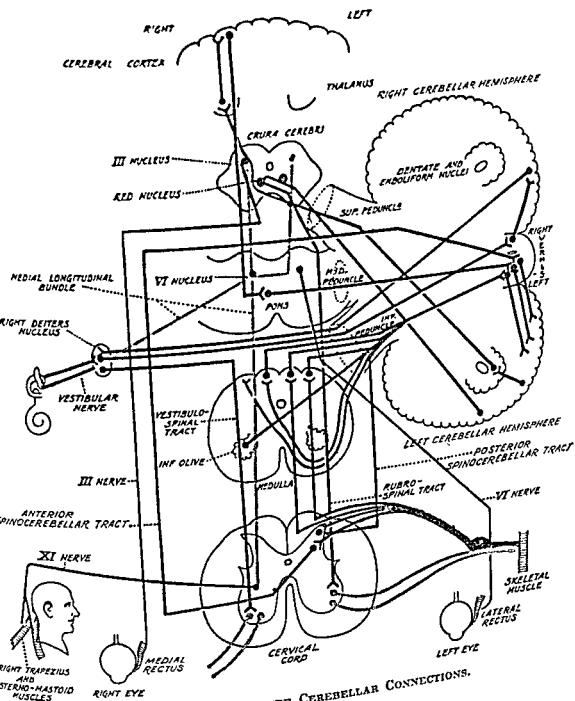


FIG. 34. DIAGRAM OF THE CEREBELLAR CONNECTIONS.

comparatively sudden onset with ataxia on the affected side, but the patient does not lose consciousness. In addition, owing to involvement of the medulla oblongata, there may be dissociated anæsthesia (loss of pain and temperature sensation, but not of touch) of the trunk and limbs on the opposite side, with homolateral dissociated anæsthesia of the face, and paralysis of the palate and vocal cord. Vomiting, dysphagia, and Horner's syndrome (see p. 441) on the affected side, may also be noted. Anti-coagulants may be given as described on p. 191 for 4 or 5 days with good results.

Cerebellar Tumours

Pathology. Benign tumours in children include the astrocytoma, and in adults the hæmangioblastoma. The medulloblastoma is the common malignant tumour.

Clinical Findings. The patient is often a child or young adult, who complains of headache, and later, disturbance of vision, vomiting and vertigo may occur.

On Examination : The generalised increased intracranial pressure accounts for the headache, vomiting and optic neuritis. The localised cerebellar lesion gives rise to a variable number of the signs described above as constituting the cerebellar syndrome. Extension of the tumour may cause paralysis of the VI nerve, or, by pressure on the pons, hemiplegia on the opposite side. If a tumour is situated in the vermis, there is a tendency for the patient to fall backwards or forwards. The medulloblastoma of the flocculonodular lobe in children causes unsteadiness of gait accompanied by walking on a wide base.

Extracerebellar Tumours

(Pontocerebellar Angle Tumours)

Pathology. A meningioma arises from the meninges covering the under surface of the cerebellum, and a neurofibroma from the sheath of a cranial nerve, generally the vestibular part of the VIII nerve.

Clinical Findings. The patient is usually an adult, who first complains of deafness and tinnitus in one ear. Later, there is headache and vertigo, the patient feeling that he is rotating to the side of the lesion, but that objects are rotating away from the side of the lesion.

On Examination : Nerve deafness is found on the affected side, and there may be signs of involvement of the VI or VII nerves, or the sensory part of the V nerve. Diminution or loss of the corneal reflex may be an early sign. The corticospinal tract on the opposite side may be affected by pressure of the medulla oblongata against the skull. There is then a spastic hemiplegia on the same side as the tumour. Symptoms of a lateral cerebellar lesion may also appear, but these will be largely masked if the corticospinal tract is involved.

Cerebellar Abscess

Clinical Findings. The patient complains of headache, occipital or frontal, and there may be vertigo and stiffness of the neck and some drowsiness. A history is sometimes given of recent mastoid or labyrinthine trouble, with deafness or tinnitus.

On Examination: The patient may be apathetic, the temperature is often raised, although sometimes it is normal. Spontaneous nystagmus may be seen, the short quick movement being towards the side of the abscess. The patient may lie on the sound side with the knees flexed. The finger-nose test often shows deviation of the arm on the affected side, in the direction of the lesion. Optic neuritis is frequently marked. Muscle hypotonus may be detected on the affected side, and dysidiadochokinesis may be easily recognised in the arms.

Differential Diagnosis. A cerebellar abscess is often hard to diagnose and may be overlooked. It may give rise to no localising signs. If it closely follows a purulent labyrinthitis no fresh signs or symptoms may be noted. Lumbar puncture serves to differentiate septic meningitis. If nystagmus persists after operation for purulent labyrinthitis, there is probably also a cerebellar abscess.

Course and Complications. The course is usually progressive. Pyæmia and purulent meningitis may occur as complications.

Prognosis. Death usually occurs in from 1 to 2 months unless the abscess can be satisfactorily drained.

Treatment. This is as for cerebral abscess (see p. 339).

Cortical Cerebellar Atrophy

The ganglion cells of the cerebellar cortex may undergo atrophy in late middle age, possibly due to arteriosclerotic changes. The gait becomes ataxic and later the arms are affected with inco-ordination and intention tremors. There is usually no nystagmus, but the plantar responses may be extensor. A subacute form has also been described associated with primary carcinoma, usually in the lungs or in the ovary. Diplopia is frequently present and dementia may rapidly ensue.

THE CRANIAL NERVES

I. The Olfactory Nerve

Anatomy. The olfactory nerves receive impulses of smell from the back of the nose. The fibres pass through the cribriform plate of the ethmoid bone and travel back to the olfactory bulb and olfactory tract, which lies in a groove on the orbital surface of the frontal lobe. The olfactory tract divides centrally into two roots, the medial crosses to end in the uncus of the opposite side, and the lateral connects with the uncus of the same side of the brain.

Lesions of the Olfactory Nerve. The nerve endings may be affected in acute or chronic rhinitis. The nerve fibres may be damaged by a fracture of the base of the skull, by pressure of a tumour of the frontal

ocular muscles. Thus the cranial autonomic fibres run in the III nerve to the ciliary ganglion, where a fresh relay starts, the short ciliary nerves, supplying the ciliary muscle and the constrictor of the pupil. The dilator muscle of the pupil is supplied by the sympathetic chain which passes to the superior cervical ganglion. A fresh relay conducts the impulses through the trigeminal (Gasserian) ganglion of the V nerve, to the ophthalmic branch of this nerve, and the impulses travel along the long ciliary nerves to the dilator muscle. With these anatomical facts clearly established, the effects of lesions at various points in the visual path are easily appreciated (see Fig. 36).

Lesions of the Optic Nerve and Visual Path. The most important affections of the optic nerve are neuritis and atrophy.

Optic Neuritis, Papillitis and Papilloedema

Definition. These terms are applied to inflammation and swelling of the head of the optic nerve within the globe of the eye.

Etiology. Optic neuritis is usually bilateral, and may be due to increased intracranial pressure, resulting in increased tension of fluid in the nerve sheath with compression of veins, or it may be a manifestation of neuro-retinitis. The most common cause of increased intracranial pressure is a tumour of the cerebrum or cerebellum. Other causes include cerebral abscess, meningitis, especially when due to tuberculosis, and chronic hydrocephalus. Neuro-retinitis may be due to nephritis, diabetes mellitus, syphilis or leukaemia. Unilateral optic neuritis results from orbital periostitis, inflammation of the orbital connective tissue, a retro-orbital tumour, localised meningitis, herpes zoster affecting the cornea, or an aneurysm of the ophthalmic or internal carotid artery.

Clinical Findings. The patient may complain of headache, but the vision may be apparently normal, although definite papilloedema is present. Later, attacks of blurred vision or definite impairment of sight occur, especially of central vision, so that reading is impossible.

On Examination: In the early stages the pupils are normal, but later they are dilated and do not react to light. Ophthalmoscopic examination shows the disc red and swollen, with a blurred edge. The retinal veins are dilated and the arteries are small. In papilloedema or choked disc, there is much oedema and swelling of the disc. In addition, in neuro-retinitis retinal changes, such as patches of exudate and hæmorrhages, are seen.

Prognosis. This depends upon the cause of the neuritis. When due to syphilis, there is usually a good response to treatment.

Treatment. A decompression operation should be performed in cases due to cerebral tumour in order to endeavour to save the sight before optic atrophy develops.

Retro-bulbar Neuritis

Definition. Inflammation of the optic nerve behind the eye.

Etiology. Retro-bulbar neuritis may be due to: 1. Multiple sclerosis,

lobe, olfactory groove or pituitary region, or by basal meningitis. Atrophy of the nerve may occur in *tabes dorsalis*. Toxins such as alcohol and nicotine, and infections such as influenza, may result in loss of smell.

Clinical Findings. The sensation of smell is tested in each nostril by asking the patient to inhale such substances as oil of cloves, peppermint, lemon, or *asafoetida*. Anosmia implies loss of smell, and in such cases food appears tasteless. In hyperosmia the patient is unduly sensitive to smells. This may be a manifestation of hysteria or result from drugs, such as strychnine or cocaine. Parosmia is a state of perverted sensation of smell, a pleasant odour being considered repugnant or *vice versa*. It occurs at times in association with a tumour or with empyema of the maxillary sinus. In epilepsy an olfactory aura may precede an attack.

II. The Optic Nerve

Anatomy (see Fig. 86). There are two visual fields, one for each eye, and each may be divided into a medial or nasal, and a lateral or temporal part. The retina of each eye may also be divided into two parts, the medial which receives impressions of objects in the temporal field of vision, and the lateral, which is the receptor for the nasal visual field. The optic nerve passes from the retina, and meeting its fellow in the mid-line, intermingles to form the optic chiasma, from which the optic tracts proceed back to connect with the primary visual centres. The fibres from the nasal halves of the retinae decussate in the optic chiasma and pass to the primary visual centres on the opposite side of the brain, whereas the fibres from the temporal halves of the retinae are carried on in the homolateral optic tract. The macular fibres from each retina undergo a partial decussation, some fibres crossing in the chiasma and others passing back in the optic tract of the same side. The primary visual centres are the lateral geniculate body, the superior colliculus and the pulvinar of the thalamus. It is very doubtful, however, whether the thalamus is a visual centre. From the lateral geniculate body relays of fibres convey the visual impulses to the cerebral cortex of the occipital lobe, especially to those convolutions situated around the calcarine sulcus in the "area striata," on the medial surface of the occipital lobe. The fibres first pass through the posterior limb of the internal capsule, and then run back in the optic radiation to the occipital cortex. Owing to the crossing of the macular fibres in the optic chiasma, the right half of each macula has its cortical centre in the right occipital lobe close to the occipital pole and the left half of the macula in the left occipital lobe. Fibres also run from the occipital lobe to the thalamus and the superior colliculus. The first relay of fibres in the optic tract which ends in the superior colliculus is situated close to the nucleus of origin of the III cranial nerve on the opposite side, and a reflex arc for light impulses is thus established between the retina and the ocular muscles. Connections are also established with the IV and VI nuclei. The III nerve, in addition to conveying fibres supplying certain extrinsic eye muscles, is also the channel for impulses passing to the intrinsic

On Examination: The pupil is dilated and does not react to light. The disc is white with a sharp margin, the surrounding retina being normal. The field of vision diminishes from the periphery, without a central scotoma.

Prognosis. This is unfavourable.

Treatment. This is unsatisfactory. If the optic atrophy is due to tabes dorsalis or general paralysis of the insane, the treatment detailed on p. 414 should be given.

Secondary Optic Atrophy

Definition. Degeneration of the optic nerve subsequent to optic neuritis.

Etiology. The causes are similar to those mentioned on p. 883 for optic neuritis, such as a cerebral tumour, aneurysm, or hydrocephalus.

Clinical Findings. The patient complains of loss of sight.

On Examination: The disc is pale, but the edges are blurred and the retinal arteries thread-like.

Prognosis. This is very unfavourable.

Treatment. No treatment is likely to be efficacious when the stage of atrophy has been reached.

The Optic Chiasma, Optic Tract, Optic Radiations and Calcarine Region

Lesions affecting these portions of the visual path are usually due to tumours, vascular disturbances, meningitis, or aneurysm of the internal carotid artery.

Clinical Findings. The fields of vision are mapped out with the aid of a perimeter. Normally the visual field is most extensive for white objects, the fields for blue, red and green objects being smaller in the order of colours given. The visual fields may be found cut off in definite directions. Thus in bitemporal hemianopia, both temporal fields are blind. This results from a lesion affecting the central part of the chiasma (see Fig. 36). In the early stages, the upper temporal quadrant of one visual field is usually first affected by tumours of the pituitary, which cause pressure from below upwards, whereas in suprasellar tumours with pressure from above downwards, the early loss is likely to occur in the lower temporal quadrant. In nasal hemianopia, the nasal visual fields are eliminated. This is a rare condition, due to a lesion affecting the outer part of the chiasma on both sides. It may be due to atheroma of the internal carotid arteries, to distension of the third ventricles due to an intracranial tumour, or to chronic internal hydrocephalus causing pressure of the outer part of the chiasma against the internal carotid arteries. In bilateral homonymous hemianopia the nasal field of one eye and the temporal field of the other are affected. This results from a lesion of the optic tract or radiation on one side. A pituitary tumour may cause such a lesion. In quadrant hemianopia, one quadrant of the visual field is affected, such as the upper half of one temporal and the upper half of the other nasal field, or the lower

syphilis affecting the optic nerve, or a hæmorrhage into the sheath of the optic nerve. 2. Sepsis in the paranasal sinuses, and possibly in other sites of the body such as the teeth. 3. Vitamin B deficiency. 4. Neuro-myelitis optica (Devic's disease). 5. Toxic causes, especially tobacco, alcohol, methyl-alcohol and tryparsamide. 6. Metabolic disturbances, such as diabetes mellitus and possibly rheumatism. Exposure to cold is a predisposing cause. 7. Mono-amine oxidase inhibitors. Colour vision is affected. Recovery occurs when the drug is omitted.

Clinical Findings. When retro-bulbar neuritis develops acutely it is usually unilateral. The patient complains of progressive loss of vision, and often there is pain on moving the eye.

On Examination : Pressure on the eyeball may cause pain. In the early stage the pupil appears normal, but it may be found that on exposure to a bright light the pupil first contracts but subsequently dilates while still exposed to the light. The disc is usually normal but there may be slight redness and blurring of the disc margin. Determination of the visual fields usually reveals a central scotoma (blind spot) where either white objects or certain coloured objects are not seen. This is due to a lesion of the papillo-macular bundle, and is called axial neuritis. The peripheral visual field may alone be restricted in interstitial peripheral neuritis. In more advanced cases sight is completely lost (diffuse neuritis), and there is optic atrophy with pallor of the optic disc.

Prognosis. This is on the whole favourable, but relapses may occur and both eyes may be affected.

Treatment. This varies with the cause. The patient should stop smoking and take no alcohol. A shade should be worn over the affected eye. Septic foci should be searched for and removed. Syphilis or diabetes mellitus, if present, must be adequately treated. If no specific cause is found iodides should be given in increasing doses, with sodium salicylate, such as Pot. iod. 5 to 30 gr. (0.3 to 2 G.), sod. salicyl. 5 gr. (0.3 G.), sod. bicarb. 10 gr. (0.6 G.), syr. aurant. 20 m. (1.2 ml.), aquam ad 1 fl. oz. (30 ml.), 1 fl. oz. (30 ml.) t.d.s. p.c.

Primary Optic Atrophy

Definition. Atrophy of the optic nerve, not preceded by a stage or optic neuritis. The distinction between primary and secondary optic atrophy is artificial and based on ophthalmoscopic findings. In all cases of primary atrophy there is some cause such as pressure on the nerve central to the entry of the vessels or a toxin affecting the nerve.

Etiology. The atrophy may be due to : 1. Nervous diseases, such as tabes dorsalis, general paralysis of the insane, amaurotic family idiocy, a frontal lobe tumour, pressure on the optic chiasma or nerve due to a pituitary tumour, and possibly multiple sclerosis. 2. Toxic substances, such as lead, arsenic in the form of Atoxyl or tryparsamide, or methylated spirit. 3. A hereditary variety, known as Leber's disease. 4. Severe hæmorrhage or anæmia. 5. Glaucoma and retinitis pigmentosa.

Clinical Findings. The patient complains of progressive loss of sight. One or both eyes may be affected.

tal fissure it ends in the superior oblique muscle. The VI nucleus is situated close to the VII nucleus in the lower part of the pons, in the floor of the fourth ventricle. It leaves the brain on its ventral surface at the lower border of the pons and runs in the medial wall of the cavernous sinus just lateral to the internal carotid artery. It passes

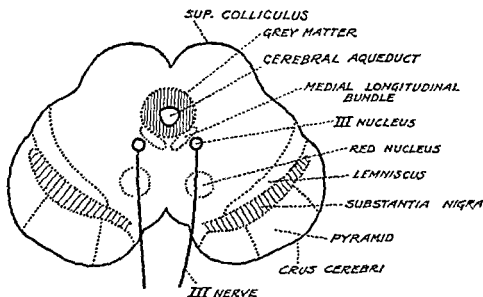


FIG. 37. DIAGRAM OF THE MID-BRAIN AT THE LEVEL OF THE SUPERIOR COLLICULI.

through the superior orbital fissure to the orbit and supplies the lateral rectus muscle. The ophthalmic branch of the V nerve also runs in the lateral wall of the cavernous sinus, the nerves being in the following order from above downwards: III, IV, ophthalmic branch of V, and VI (see Fig. 31).

The Oculo-motor Muscles. The external muscles of the eye produce movements of the eyeball in three directions: 1. Vertical, an upwards or downwards movement. 2. Horizontal, an inwards or outwards

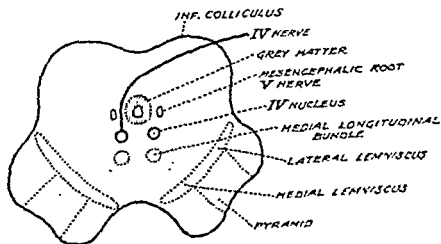


FIG. 38. DIAGRAM OF THE MID-BRAIN AT THE LEVEL OF THE INFERIOR COLLICULI.

half of one temporal and the lower half of the other nasal field. This results from a lesion around the calcarine sulcus, the superior quadrant of the visual field being represented below the calcarine sulcus, and the inferior quadrant of the visual field above the calcarine sulcus. When the occipital pole is affected there may be central blindness, half the macula on each side being represented on each occipital pole (see Fig. 36). Lesions of the occipital cortex may result in mind-blindness (optic agnosia), the patient sees objects but cannot recognise them. Visual hallucinations may also occur. Wernicke's hemiopic pupillary reaction is described as an aid to determine whether a lesion of the visual path is situated before or behind the primary visual centre of the superior colliculus. A narrow beam of light is cast into the eye by an ophthalmoscope mirror on to the blind half of the retina. If the pupil contracts the light reflex fibres are not involved and so the lesion is situated behind the primary visual centre, *i.e.*, in the internal capsule, optical radiation or cortex. In practice it is very difficult to carry out this test.

Amaurosis is a term used to indicate blindness. Uræmic amaurosis may occur in the course of acute or chronic nephritis. The patient suddenly becomes blind in one or both eyes. The pupils are dilated but react to light. The discs and fundi are normal apart from any changes associated with the nephritis. There is usually spontaneous recovery in the course of a day or so (see p. 495).

Amblyopia indicates some dimness of vision. In hysterical amblyopia the pupils and fundi are normal, but the fields of vision show a spiral restriction during testing, either from within outwards, or from without inwards, according to the manner in which the test is conducted. Hemianopia may also occur in hysteria or in migraine.

The III, IV, and VI Nerves

(The Oculo-motor Nerves)

Anatomy. The III nucleus lies in the mid-brain at the level of the superior colliculi in the floor of the cerebral aqueduct. Some fibres cross, joining the III nerve of the opposite side. The nerve leaves the brain on the ventral surface near the mid-line on the medial side of the crus, and passes through the lateral wall of the cavernous sinus to enter the orbit through the superior orbital fissure (see Fig. 37). It divides into a superior ramus supplying the levator palpebræ superioris and the rectus superior muscles, and an inferior ramus distributed to the recti inferior and lateralis and the inferior oblique muscles. It also gives fibres to the ciliary ganglion from which the short ciliary nerves run to the ciliary muscle and the constrictor of the pupil. The IV nucleus is situated in the mid-brain at the level of the inferior colliculi in the ventral part of the central grey matter. The IV nerves decussate below the inferior colliculi and emerge from the dorsal aspect of the anterior medullary velum (see Fig. 38). The nerve passes forwards around the crus cerebri and runs in the lateral wall of the cavernous sinus below the III nerve. Passing through the superior orbi-

tal fissure it ends in the superior oblique muscle. The VI nucleus is situated close to the VII nucleus in the lower part of the pons, in the floor of the fourth ventricle. It leaves the brain on its ventral surface at the lower border of the pons and runs in the medial wall of the cavernous sinus just lateral to the internal carotid artery. It passes

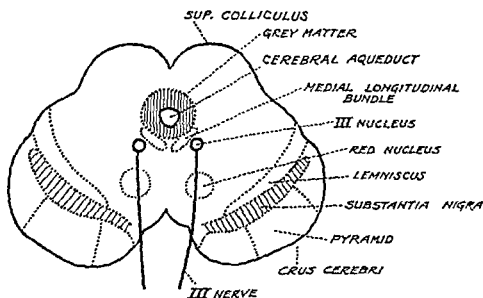


FIG. 37. DIAGRAM OF THE MID-BRAIN AT THE LEVEL OF THE SUPERIOR COLLICULI.

through the superior orbital fissure to the orbit and supplies the lateral rectus muscle. The ophthalmic branch of the V nerve also runs in the lateral wall of the cavernous sinus, the nerves being in the following order from above downwards: III, IV, ophthalmic branch of V, and VI (see Fig. 31).

The Oculo-motor Muscles. The external muscles of the eye produce movements of the eyeball in three directions: 1. Vertical, an upwards or downwards movement. 2. Horizontal, an inwards or outwards

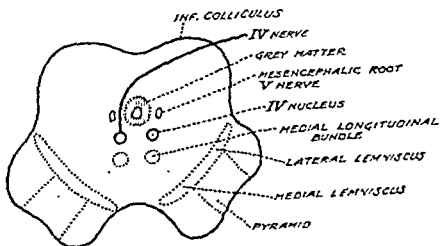


FIG. 38. DIAGRAM OF THE MID-BRAIN AT THE LEVEL OF THE INFERIOR COLLICULI.

movement. 8. Torsion or wheel motion, the vertical meridian being rotated inwards or outwards.

The movements effected by the muscles are as follows : *The lateral rectus muscle.* This moves the eye outwards. *The medial rectus muscle.* This moves the eye inwards. *The superior rectus muscle.* This moves the eye upwards and inwards, and rotates or twists it inwards. *The inferior rectus muscle.* This moves the eye downwards and inwards, and twists it outwards. *The superior oblique muscle.* This moves the eye downwards and outwards, and twists it inwards. *The inferior oblique muscle.* This moves the eye upwards and outwards, and twists it outwards. *Diplopia* or double vision results from paralysis of the external ocular muscles. It results from the axes of the eyeballs not being parallel when an object is looked at. The patient therefore sees two objects, as the images do not fall on corresponding parts of the retinae. The true image is the one seen by the sound eye. It is more distinct than the false image which is seen by the affected eye. A

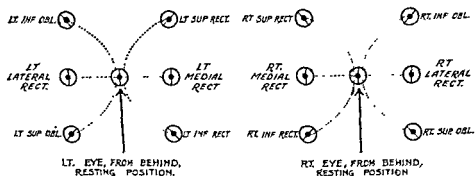


FIG. 39. DIAGRAM OF THE ACTION OF THE OCULO-MOTOR MUSCLES.
(After Swanzy and Werner.)

red glass is put before the affected eye and an object such as a candle is looked at, the false image then appears red and the true image white. In homonymous or simple diplopia the false image appears on the side of the true image corresponding with the side of the lesion, e.g., if the left eye is affected, then the false image is to the left of the true image, or *vice versa*. This is the case always in convergent (medial) strabismus. In crossed diplopia the false image is situated on the opposite side of the true image. This occurs in divergent (lateral) strabismus. The action produced by the various oculo-motor muscles can be seen from the accompanying diagram (see Fig. 39).

The movements upwards, downwards, inwards and outwards, and the torsion movements of the eyeball produced by the various muscles are all represented. Thus the left inferior oblique moves the eyeball upwards and outwards, and rotates or twists it outwards. The position of the false images can also be conveniently represented by a similar diagram, the false image being featured by the dotted line drawing of the candle (see Fig. 40). The false image is always situated in the direction of pull of the paralysed muscle.

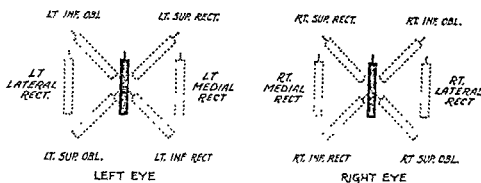


FIG. 40. DIAGRAM OF FALSE IMAGES IN OCULO-MOTOR PALSIES.
(After Swanzy and Werner.)

Paralysis of the rectus superior muscle. There is weakness in moving the eye upwards and inwards. The diplopia is present on looking upwards, it is crossed, the false image being above and tilted away from the true image. *Paralysis of the rectus inferior muscle.* There is weakness in moving the eye downwards and inwards. The diplopia is present on looking downwards, it is crossed, the false image being below and tilted towards the true image. *Paralysis of the lateral rectus.* There is inability to move the eye outwards. The diplopia is homonymous, the false image is on the same level as the true one, and on the same side of it as is the lesion. Thus with a left lateral rectus paralysis the patient complains of diplopia when he looks to the left. There is a medial strabismus, the affected eye being turned inwards by the unopposed action of the medial rectus. The head may be kept a little turned to the affected side. Secondary deviation may be detected in the sound eye. Thus if the patient is asked to look outwards with the affected eye, and the sound eye is screened, the sound eye moves inwards to a greater degree than the affected eye moves outwards. This is because a greater stimulus than normal is given to the affected eye to try and cause it to move, and a correspondingly greater contraction takes place in the medial rectus of the sound eye, which normally works in unison with the lateral rectus of the other eye. The farther the test object is moved to the affected side, in determining the diplopia, the greater is the distance between the true and false images. The patient also misjudges distances on looking to the affected side, the object appearing farther away than it really is. *Paralysis of the medial rectus.* There is inability to move the eye to the affected side. There is lateral strabismus. The patient has crossed diplopia on looking inwards, the false image being on the opposite side, but on the same level as the true one. *Paralysis of the inferior oblique.* There is weakness in moving the eye upwards and outwards, and in rotating outwards. There is diplopia on looking upwards. The patient may elevate the head and then look downwards to avert the diplopia which is homonymous, the false image being situated above and tilted away from the true image. *Paralysis of the superior oblique.* There is weakness in moving the eye downwards and outwards, and in rotating it inwards. The patient complains of diplopia and giddiness on looking

down, as on descending a flight of stairs. The diplopia is homonymous, the false image is below and tilted towards the true image.

Lesions of the Oculo-motor Nerves. Lesions may occur in three portions of the motor tract from the cerebral cortex to the muscles of the eye. 1. Supranuclear lesions in the cortex, corona radiata, internal capsule or mid-brain. 2. Nuclear, affecting the III, IV or VI nuclei. 3. Infranuclear, affecting the nerves themselves.

Supranuclear Lesions

Etiology. These may result from vascular disturbances, such as hæmorrhage, thrombosis or embolus, or from the pressure of a tumour. The cortical centre for eye movements is thought to be situated in the region of the middle frontal gyrus.

Clinical Findings. Both eyes are affected. There is usually a disturbance of conjugated lateral movements. In bilateral internal capsular lesions, or in unilateral mid-brain lesions in the region of the superior colliculi or cerebral aqueduct there may be disturbance of conjugated vertical movements of both eyes. There is usually an associated hemiplegia. Thus with a right-sided lesion there is paralysis of the left side of the body, with conjugate deviation of the eyes. The direction of this deviation depends upon whether the lesion is an irritative or a paralytic one. With an irritative lesion the eyes look away from the lesion, *i.e.*, if the lesion is on the right side of the brain, the eyes are deviated to the left. The reverse holds good with a paralytic lesion. This is explained by reference to the diagram (see Fig. 41). The cortical lesion affects the VI nucleus on the opposite side, and the VI nucleus is connected to, and works synergically with the portion of the III nucleus of the opposite side which supplies the medial rectus muscle.

Treatment. This varies with the cause, as for cerebral vascular lesions or tumours.

Nuclear Lesions

Etiology. The oculo-motor nuclei may be stimulated or paralysed by such lesions as a hæmorrhage, thrombosis or embolus, a mid-brain or pontine tumour. A cerebellar tumour may affect the VI nerve nucleus by indirect pressure. Other lesions include those produced by acute encephalitis occurring as a complication of measles, influenza, scarlet fever or small-pox, encephalitis lethargica, tabes dorsalis, syringomyelia, chronic poliomyelitis, multiple sclerosis, Wernicke's encephalopathy (see p. 663), and botulism. A nuclear lesion may also occur in myasthenia gravis.

Clinical Findings. Nuclear ophthalmoplegia may appear as an acute or chronic disease. In the acute variety there is often headache and vomiting, with a raised temperature. Both eyes are affected, usually groups of muscles, but not all the muscles are involved. There may also be internal ophthalmoplegia, the pupil being moderately dilated, and showing no response to light or to accommodation; usually, however, the intraocular muscles are not affected. An irritative nuclear

lesion causes a conjugate deviation of the eyes, so that they look towards the side of the lesion, and a paralytic lesion has the converse effect. This is the reverse of what occurs in a supranuclear lesion, and is explained by the diagram (see Fig. 41). If the corticospinal tract

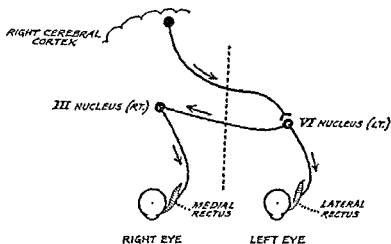


FIG. 41. DIAGRAM OF THE MECHANISM OF CONJUGATE DEVIATION OF THE EYES.

is affected, there is hemiplegia on the side of the body opposite to the lesion (Weber's syndrome). If the rubrospinal tract is also involved there are involuntary tremors of the opposite side of the body. Chronic nuclear paralysis is more often met with. The onset of the symptoms is insidious; there is usually conjugate deviation of the eyes, the patient not being able to turn the eyes in one lateral direction. It is often difficult to differentiate between single nuclear lesions and infranuclear lesions when only one muscle is affected. If, in addition to some of the muscles supplied by the III nerve, the orbicularis oculi muscle is also paralysed, the lesion is probably a nuclear one. Lesions of the VI nucleus are usually accompanied by a VII nerve nuclear lesion as well. A VI left nuclear lesion causes conjugate paralysis to the left side, but if the left eye is covered, the right eye can be moved medially, and both eyes will converge.

Jaw-winking may occur in cases of congenital ptosis. When the jaw is depressed to the opposite side by contraction of the lateral pterygoid muscle of the same side, the impulse, passing along the V nerve, causes the upper lid on the same side to be twitched up, the paralysed levator palpebræ superioris contracting. It is usually unilateral.

Infranuclear Lesions

Etiology. The oculo-motor nerves may be affected at different parts of their course: 1. *In the brain.* The lesions here are usually vascular or due to tumours. Increased intracranial pressure, associated either with supra- or infratentorial growths, by stretching the nerve, may cause VI nerve paralysis. This constitutes a false localising sign of a VI nerve lesion. 2. *Between the pons and the orbit.* The lesion may

be meningitis, often syphilitic, a gumma, an intracranial tumour, neuritis due to diphtheria, diabetes mellitus, or less often due to lead, alcohol or nicotine, toxic neuritis from septic foci elsewhere, fractured base of the skull, cavernous sinus thrombosis, aneurysm or atheroma of the internal carotid or posterior communicating artery, and subarachnoid hæmorrhage. The VI and V nerves may be affected in acute mastoiditis in children, probably due to a localised meningitis. In *Gradenigo's syndrome* there is weakness of the lateral rectus muscle on one side, due to involvement of the VI nerve by inflammation of the apex of the petrous bone in association with otitis media. The patient is ill with fever, and complains of a headache on the same side. Ophthalmoplegic migraine may be due to unilateral distension of the lateral ventricle. *The superior orbital fissure syndrome.* Acute periostitis may cause infranuclear paralysis, a condition comparable with peripheral facial palsy. There is then pain in the eye with partial or total ophthalmoplegia and proptosis. The ophthalmic and maxillary divisions of the V nerve may also be involved with cutaneous anæsthesia over their area of distribution. Overgrowth of bone, as in leontiasis ossea, may cause pressure paralysis. Other causes of the syndrome are aneurysm of the internal carotid artery and meningeal tumour. In these cases proptosis is liable to occur. The nerves are likely to be involved in the following order: VI, IV, ophthalmic division of V, III, and maxillary division of V. It then results in ophthalmoplegia, anæsthesia of the eye, cheek and half the forehead, with severe pain. 3. *In the orbit.* The nerves may be involved in retro-orbital tumours, or inflammation of the connective tissue behind the eye. 4. *The terminations of the nerve in the ciliary muscle and constrictor of the pupil.* The vegetable mydriatic alkaloids, atropine, hyoscyamus, and hyoscine, cause paralysis by affecting the myoneuronal junctions.

Clinical Findings. One or more of the III, IV and VI nerves may be involved.

The Third Nerve. All the muscles supplied by the nerve or only some of them may be paralysed. With a complete third nerve paralysis there is ptosis with compensatory contraction of the occipitofrontalis muscle, as shown by wrinkling of the forehead. The eyeball is deviated outwards by contraction of the lateral rectus muscle. It cannot be turned inwards or upwards, and only slightly downwards. The superior oblique muscle may cause by its action a slight downward and outward movement, in a wheel-like manner. The pupil is moderately dilated, and does not contract to light or to accommodation. The results of partial III nerve paralysis have been considered above under paralyses of the various muscles. *Internal ophthalmoplegia.* The ciliary muscle and the constrictor and the dilator of the iris may be paralysed. The pupil is usually of medium size and does not react to light or to accommodation. Internal ophthalmoplegia may be due to a lesion of a portion of the III nucleus or of the fibres passing to the ciliary ganglion, or of the trigeminal ganglion. In post-diphtheritic paralysis the ophthalmoplegia may be unilateral or bilateral.

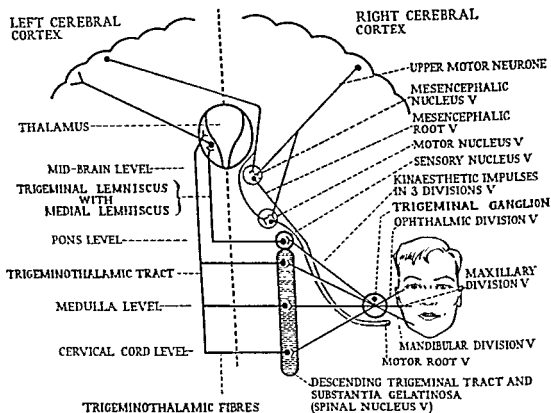


FIG. 42. DIAGRAM OF THE CENTRAL PATH OF THE V NERVE.

The V Nerve

(Trigeminal Nerve)

Anatomy. The V nerve leaves the brain on the ventral aspect of the middle of the pons by a large sensory and a small motor root. The motor nucleus lies in the upper part of the pons, under the lateral part of the floor of the fourth ventricle. The mesencephalic nucleus and mesencephalic root extend from the upper part of the mid-brain to the level of the motor nucleus. It is usually considered to be motor in function. Upper motor neurones pass from the cerebral cortex on each side to connect with these motor nuclei. Thence, lower motor neurones pass out from the pons in the V nerve. Some authorities believe that the mesencephalic nucleus is composed of cells analogous to the trigeminal ganglion and spinal ganglia which have migrated into the brain, and convey proprioceptive impulses from the masticatory muscles. The trigeminal ganglion contains the cells of origin of the sensory fibres which enter the pons. Some of the fibres, conveying kinæsthetic sensations from the three divisions of the V nerve pass to the sensory superior nucleus, relay there, cross the mid-line, and ascend as the trigeminal lemniscus to relay in the thalamus. Thence, the impulses pass to the cerebral cortex. Others, conveying pain and temperature sensations, run down the pons, medulla oblongata and spinal medulla (cord) to the level of the 2nd or 3rd cervical segment as the spinal or "ascending" root, ending at different levels in the spinal nucleus in the substantia gelatinosa. These fibres form the descending trigeminal tract.

The second relay from the substantia gelatinosa passes to the opposite side as the trigeminothalamic fibres, and ascend as the trigeminothalamic tract to end in the lateral nucleus of the thalamus. The sensory fibres in the mandibular, maxillary and ophthalmic divisions, conveying pain and temperature sensations, decussate in the trigeminal ganglion, so that they end in the spinal nucleus in this order from above downwards, inversely to their distribution to the face (see Fig. 42).

The V nerve, after leaving the pons, passes forwards over the petrous bone, where the trigeminal ganglion is situated on the sensory part of the nerve, the motor part lying beneath this ganglion. Three main nerves emerge from the trigeminal ganglion, named the ophthalmic or first, the maxillary or second, and the mandibular or third division. The motor nerve is attached to the third division. The ophthalmic nerve runs in the lateral wall of the cavernous sinus and passing through the superior orbital fissure to the orbit, terminates in the lacrimal, frontal and nasociliary nerves. In the cavernous sinus it gives a branch to the dura mater. The lacrimal nerve supplies the lacrimal gland, the conjunctiva, cornea, and the lateral angle of the eye. The frontal nerve divides into the supra-orbital and supratrochlear nerves, and supplies the skin on the front half of the scalp and forehead, the root of the nose and medial angle of the eye, the upper eyelid and the frontal sinus. The nasociliary nerve supplies the mucous membrane of the upper part of the nose, and the skin of the lower part and tip of the nose. It receives

a communicating branch from the ciliary ganglion, and gives off the long ciliary, the infratrochlear and the posterior ethmoidal nerves.

The maxillary nerve runs along the lower part of the cavernous sinus, enters the foramen rotundum and pterygopalatine fossa, and traverses the orbit to appear on the face through the infra-orbital foramen. In the skull it gives a recurrent branch to the dura mater. In the infra-orbital canal it supplies branches to the teeth of the upper jaw. Its cutaneous branches are distributed to the face between the lower eyelid, side of the nose and upper lip. Branches are also given to the mucous membrane of the hard palate and the maxillary sinus. *The mandibular nerve* leaves the skull through the foramen ovale, and gives a recurrent branch to the dura mater. The motor fibres supply the following muscles: The masseter, the temporal, the lateral and medial pterygoids, the mylohyoid, the anterior belly of the digastric, the tensor tympani and the tensor veli palatini. The auriculo-temporal branch supplies cutaneous branches to the temple and scalp, and to the external acoustic meatus and upper part of the pinna. This nerve also gives branches to the parotid gland and the temporo-mandibular joint. *The lingual branch* supplies the tactile filiform papillae in the anterior two-thirds of the tongue. The chorda tympani nerve joins the lingual nerve, and conveys taste sensations from the tongue to the VII nerve, and then to the glosso-pharyngeal nucleus. The inferior alveolar (dental) branch supplies the teeth of the lower jaw, and emerging through the mental foramen innervates the skin over the chin and lower lip. The mucous membrane of the mouth, gums and auditory (Eustachian) tube is also supplied by this division of the V nerve.

Lesions of V Nerve. The following varieties of lesions may occur:

1. *Supranuclear Lesions.* The cortical centres for the muscles innervated by the V nerve are situated in the lower third of the precentral gyrus. These centres are bilateral, each centre sending fibres to both V nuclei, and so both centres must be put out of action to cause an upper motor neurone paralysis of the masticatory muscles. Lesions may occur here, in the corona radiata, internal capsule, or mid-brain. They are rare and include meningeal and vascular disturbances and tumours. In epilepsy, hydrophobia and post-encephalitic syndromes supranuclear disturbances of the V nerve may occur. In paralysis agitans there is probably a lesion in the corpora striata disturbing the fibres in the internal capsule. In strychnine poisoning and tetanus, the lesion is probably situated in the synapses connecting the upper motor neurones with the nuclear cells.

2. *Nuclear Lesions.* These are situated in the pons and include hæmorrhage, tumour, gumma, polioencephalitis, multiple sclerosis, bulbar paralysis, amyotrophic lateral sclerosis and syringomyelia.

3. *Infranuclear Lesions.* The V nerve may be affected at the base of the brain by meningitis or fracture of the base of the skull, or its branches may be involved by a tumour, thrombosis of the cavernous sinus, an aneurysm of the internal carotid artery and cellulitis of the orbit. The trigeminal ganglion may be inflamed, or the branches of the V nerve involved in a neuritis, such as occurs in diphtheria.

Clinical Findings. Disturbances of the V nerve may affect chiefly

the motor or sensory fibres or combined lesions may occur. 1. *Motor Lesions.* These may be irritative or paralytic. (a) *Irritative lesions.* Tonic or clonic contractions of the masticatory muscles occur. The former are known as trismus, and may be present in tetanus, epilepsy, tetany, or strychnine poisoning. Clonic spasms are seen with rigors and paralysis agitans, etc. Nocturnal jaw-grinding is a functional nervous disturbance, and thought to be an indication of mental protest. (b) *Paralytic lesions.* Supranuclear lesions, when bilateral, are characterised by paralysis of the lower jaw. The patient can neither close the mouth, protrude the jaw, nor move it from side to side. Food tends to drop from the mouth. There is no wasting of the muscles and no reaction of degeneration. Nuclear lesions are often bilateral, with a flaccid paralysis of the masticatory muscles on both sides. Infranuclear lesions are usually unilateral. There is often wasting and weakness of the muscles of mastication on one side of the face. When the patient opens his mouth the lower jaw is pushed to the paralysed side by the action of the opposite lateral pterygoid muscle. This is best judged by the position of the central incisors of the upper jaw when the mouth is open and closed. There is inability to move the jaw laterally to the sound side, and on opening the mouth the condylar process of the lower jaw can be felt not to move forwards on the affected side. When the patient is asked to bite, it can be felt that the masseter and temporal muscles do not contract, and some flaccidity of the floor of the mouth may be found on pressing below the chin. The jaw-jerk is absent, and the affected muscles show a reaction of degeneration.

2. *Sensory Lesions.* (a) *Loss of sensation.* An upper motor neurone lesion affecting the posterior part of the internal capsule may cause loss of sensation of the face, the arm, body and leg on the opposite side of the body (crossed hemianæsthesia). A lesion of the spinal root of the V nerve and the medial lemniscus on the same side will cause "alternate hemianæsthesia," the face on one side, and the arm, body and leg on the other side being affected. Lower motor neurone lesions may affect individual branches of the V nerve. Thus in periostitis of the orbit the ophthalmic division may be affected with certain oculomotor nerves as described on p. 392. There is then blunting of sensation in the cutaneous area of this nerve around the orbit and forehead and the corneal and conjunctival reflexes may be abolished with diminished tear secretion. When the maxillary and mandibular branches are involved, in addition to the cutaneous anæsthesia, the patient cannot feel his tongue and cheek normally, and is apt to bite it, and in drinking from a glass he can only feel half the glass touching his lip. There may also be diminished secretion of saliva on one side, the tongue is dry and furred on the affected side, and using a tuning fork of low pitch, there may be loss of appreciation for low notes. Anæsthesia is found in the cheek and gums. Smell may be diminished on one side, owing to dryness of the nasal mucous membrane. Taste is not affected unless the chorda tympani nerve is also involved. Segmental blunting or loss of sensation may also occur, limited to trigeminal dermatomes around the mouth. The teeth on the affected side may fall out. Facial

or corneal herpes and corneal ulceration may also be a manifestation of lesions of the sensory division of the V nerve or of the trigeminal ganglion.

(b) *Trigeminal neuralgia*. This may be of a minor degree with pain situated in the region of certain branches of V nerve. Thus there may be supra-orbital neuralgia associated with frontal sinusitis. Tenderness may be found at the supra-orbital notch. Headache may be due to involvement of the branches supplying the dura mater. The severe type of trigeminal neuralgia is known as *tic douloureux*. This is an affection of middle age or later, but it is occasionally met with in children. There are periodical paroxysms of agonising pain in the face, especially in the areas supplied by the second and third divisions of the V nerve. The pain may spread to the neck. A paroxysm lasts for a few seconds or minutes, and tends to recur frequently. During the attack the face may become flushed and moist with perspiration, and there may be watering of the eyes and mouth, and twitching of the facial muscles. The attack may be provoked by the slightest stimulus to the trigger area, such as a draught, washing or shaving, cleaning the teeth or eating. In patients under the age of 40 it may be a manifestation of multiple sclerosis. Facial pain may also be associated with periodic migrainous neuralgia, toothache, inflammation of the temporomandibular joint, sinusitis, nasopharyngeal malignant growths, otitis, cervical spondylosis, and a posterior fossa neoplasm.

On Examination: Tender spots may be found over the infra-orbital or mental foramina.

Treatment. In all cases of trigeminal neuralgia the paranasal sinuses should be investigated; frontal sinusitis may result in supra-orbital or supratrochlear neuralgia. The pain is best relieved by local heat, which can be conveniently applied by a rubber hot-water bottle. A nasal spray should also be used containing some preparation, such as the Chlorotone Inhalant. Dental extraction rarely relieves the pain, and should not be advised unless an obviously diseased tooth is present. In *tic douloureux* the patient should have complete rest in bed for several weeks, and for the pain the following mixture may be given: Tnc. gelsemii 10 m. (0.6 ml.), sod. salicyl. 5 gr. (0.3 G.), sod. bicarb. 20 gr. (1.2 G.), sod. brom. 10 gr. (0.6 G.), syr. aurant. 20 m. (1.2 ml.), aquam ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s. p.c. Good results have been reported by the daily subcutaneous injection of 1,000 micrograms of vitamin B₁₂ (cyanocobalamin) for 10 to 14 days, followed by a similar dose twice a week for several months. 5-carbamoyl-5H-dibenzazepine (Tegretol) 200 mg. tab. t.i.d. affords relief in some cases. In severe and protracted cases relief may in some cases be obtained for several months by injecting the trigeminal ganglion or its branches with 10 to 15 m. (0.6 to 0.9 ml.) of 80% alcohol through the foramen ovale or foramen rotundum. This is an operation which should only be performed by a specialist. It may be repeated later if the pain recurs. In very severe cases ganglionectomy, or resection of the dorsal nerve root inside the skull, may be necessary to relieve the pain. Even then the patient may still feel pain, although the sensory fibres are cut off from the brain. This

is comparable with the sensation which may be felt in the toes after a leg has been amputated.

3. *Trophic Lesions.* It has been mentioned above that corneal ulceration may follow lesions of the first division of the V nerve. If the eye is protected by a shade from the irritation of dust, etc., these lesions do not occur. They are probably mechanically produced, the irritants not being removed by blinking, as they are not felt. Facial hemiatrophy is a peculiar condition in which there is wasting in structures supplied by the V nerve on one side. The cause is not known, but it may be due to any nuclear or infranuclear trophic disturbance of the V nerve, and is at times associated with osteitis of the jaw, or it may follow erysipelas. The bones, cartilages and soft tissues are affected, chiefly in the areas supplied by the second and third divisions of the V nerve. One side of the face is smaller than the other. The skin becomes thin and the subcutaneous fat disappears; there may also be atrophy of half of the tongue. There are no sensory changes, the muscles are not paralysed, and there is no reaction of degeneration.

The auriculotemporal syndrome consists of flushing and sweating on eating in the area of skin supplied by the auriculotemporal nerve. It is met with in association with parotid gland suppuration, or after an operation on, or a wound of, the gland. The nature of the reflex has not been adequately explained.

of the digastric muscle. The VII nerve then divides into the temporo-facial and cervico-facial branches. The former supplies the corrugator supercilii, the frontal belly of the occipitofrontalis, the orbicularis oculi and the zygomatic muscles, and the latter the buccinator, orbicularis oris and platysma muscles (see Fig. 43). The sensory part of the nerve is considered to be formed by the nervus intermedius (of Wrisberg), which runs from the genicular ganglion to the tractus solitarius portion of the glossopharyngeal nucleus in the medulla oblongata. The taste fibres in the chorda tympani nerve pass from the genicular ganglion to the nervus intermedius. The genicular ganglion is also joined by the greater, the lesser and the external petrosal nerves, which carry sympathetic and taste fibres. Further sensory fibres conveying deep pain and pressure sensations run in the peripheral divisions of the facial nerve, and pass through the genicular ganglion to the nervus intermedius (of Wrisberg).

Lesions of the VII Nerve. 1. *Supranuclear.* The lesion may be situated in the cerebral cortex (lower part of the precentral gyrus), the corona radiata, genu of the internal capsule, or in the suprapontine region. The lesions include a cerebral tumour, abscess or vascular lesion such as a hæmorrhage, thrombosis or embolus. 2. *Nuclear.* In the pons: A tumour, such as a glioma, a vascular lesion, encephalitis lethargica, multiple sclerosis, bulbar paralysis, polioencephalitis, and tabes dorsalis. 3. *Infranuclear.* (a) *At the base of the brain.* Tumours of the cerebello-pontine angle, basal meningitis, a gumma, aneurysm of the basilar artery, or a fractured base. (b) *In the temporal bone.* Caries associated with otitis media, toxæmic neuritis, an operation on the mastoid. (c) *In the stylo-mastoid foramen.* Fibrositis of the process of the posterior part of the parotid sheath which enters the foramen, associated with exposure to cold. (d) *In the face.* A tumour or inflammation of the parotid gland, as in ureoparotid sarcoidosis. Injury from a wound or from forceps at birth. Neuritis due to such causes as alcohol, diphtheria, diabetes mellitus or leprosy.

Clinical Findings. 1. *Supranuclear Lesions.* (a) *Irritative.* With cortical lesions irritating the motor centre unilateral facial contractions may occur on the opposite side of the face. There are often associated movements of the eyes and tongue. In dementia paralytica peri-oral fibrillary tremors may be noted. (b) *Paralytic.* There is paralysis chiefly affecting the lower part of the face of the opposite side, the upper part is much less likely to be paralysed, owing to the bilateral representation of the cortical centres in respect to their supply to the upper part of the face. Thus, although the mouth appears drawn over to the sound side and the orbicularis oris muscle is paralysed on the affected side, the patient can close both eyes and wrinkle his forehead. The paralysed muscles do not atrophy and there is no reaction of degeneration. Taste is not affected. In addition there is frequently hemiplegia, the arm, body and leg being paralysed on the same side as the face, when the lesion is a capsular one. Although the patient cannot contract the facial muscles voluntarily on one side, he may do so under the influence of emotion. Thus a joke may cause him to smile with

both sides of his face, in fact the facial contraction may be exaggerated on the paralysed side. This is not the case in infranuclear lesions.

2. *Nuclear Lesions.* There is paralysis of the upper and lower half of the face on the same side as the lesion. The muscles atrophy and show the reaction of degeneration. Further, there is often paralysis of the lateral rectus muscle of the eye on the same side, due to involvement of the contiguous VI nucleus. If the corticospinal tract is also affected there is spastic hemiplegia of the opposite side of the body.

8. *Infranuclear Lesions.* (a) *Irritative.* Severe facial spasms may occur, functional tremors of the eyelids and facial tics are also of this nature. (b) *Paralytic* (Bell's palsies). The clinical results vary according to the site at which the lesion is situated, as described below: (a) *Between the pons and genicular ganglion.* There is paralysis on the same side of the upper and lower half of the face, of the lower motor neurone type (see below, section (d)). The VIII nerve may also be involved with deafness or tinnitus, or the V nerve with paralysis or sensory disturbances, and if the nerve to the stapedius is affected there may be hyperacusis to sounds of low or high pitch. Taste is not affected unless the nervus intermedius (of Wrisberg) is also involved. (b) *At the genicular ganglion.* There is paralysis on the same side of the upper and lower half of the face, and herpes located to the ear and external acoustic meatus (herpes oticus or Ramsay Hunt syndrome) with pain, which may result from inflammatory lesions. The chorda tympani nerve fibres may also be affected with loss of taste on the anterior two-thirds of the tongue on the same side. (c) *Between the genicular ganglion and the chorda tympani nerve.* There is paralysis on the same side of the upper and lower half of the face (see below, section (d)). There is loss of taste on the anterior two-thirds of the tongue on the same side. If the lesion is proximal to the junction of the nerve to the stapedius there may be tinnitus and hyperacusis for notes of high or low pitch. Salivary secretion may be diminished on the same side. (d) *Peripheral to the junction of the chorda tympani nerve.* (The usual type of Bell's palsy.) This may follow exposure to cold or sitting in a draught near an open window. Both sexes are equally affected. The patient is usually an adult over the age of 20. He may notice some pain or tenderness behind the ear for a day or so, and then suddenly finds that he cannot move one side of the face normally and this side of the face may feel stiff. He may also find that when eating he tends to bite his cheek or lower lip on one side, and the food may collect between the cheek and teeth on this side. Tears may also run down the cheek on the affected side, due to paralysis of the orbicularis oculi muscle. Bell's original case (1827) was traumatic in origin, the patient having been tossed by a bull.

eye on one side (lagophthalmos), and on trying to do so the eyeball moves upwards and either slightly inwards or outwards, owing to a connection between the VII and a portion of the III nucleus. If the patient is observed during sleep the affected eye may be nearly closed. He is asked to frown and to raise his eyebrows and is unable to do so on the paralysed side. The lower part of the face is tested by asking the patient to show his teeth, the angle of the mouth is drawn outwards on the sound side and does not move out on the paralysed side. He is then asked to blow out his cheeks, to smile and to whistle. He cannot do so on the paralysed side. Spontaneous emotions also fail to provoke a contraction of the oral muscles on the paralysed side, in contrast to that which may occur in organic supranuclear lesions with hemiplegia and facial paralysis. Paralysis of the platysma muscle may sometimes be detected by making the patient depress his chin against the resistance of the examiner's hand, when it may be seen, by looking at the skin under the chin, that the platysma does not contract on one side. The affected muscles atrophy and may give a reaction of degeneration. In the course of a few days the lesion may spread up to involve the chorda tympani nerve. Taste is then lost on the affected side of the anterior two-thirds of the tongue. It is tested for as follows: The patient is given a card on which the words "Sweet. Salt. Sour. Bitter." are written, and he is told to point to the word representing the sensation he experiences when the test substance is applied to the tongue. He must not withdraw his tongue into his mouth until he has indicated the sensation. Sugar, salt, citric acid and quinine are employed as the test substances. A small portion is applied in turn to the outer side of the anterior part of the tongue and gently rubbed in with cotton wool. If the inflammation spreads still further up the VII nerve above the level of the junction of the nerve to the stapedius, there may be tinnitus and hyperacusis to notes of high or low pitch.

Differential Diagnosis. There is usually no difficulty in diagnosing a Bell's palsy; the distinctions between upper and lower motor neurone lesions described above, should be remembered. In facio-scapulo-humeral myopathy, usually both sides of the face are affected and also other muscles of the body, which differentiates it from a double facial paralysis. In facial hemiatrophy there is wasting but not paralysis of the muscles of one side of the face.

Course and Complications. The paralysis may disappear in a week or so, or persist for nearly 2 years. Recovery usually is first apparent in the upper half of the face. Subsequent twitching or contractures of the affected muscles may occur, when the recovery is not complete. Thus the eye on the affected side may be narrow, or the corner of the mouth drawn outwards. "Crocodile tears" may also be expected in cases of incomplete recovery. When the patient masticates and salivates, tears flow from the eye on the affected side as the result of stimulation of the lacrimal gland. The crocodile is alleged to shed hypocritical tears before devouring its prey.

Prognosis. The prognosis in Bell's palsy depends upon the cause. In the usual type due to fibrositis or periostitis there is recovery in

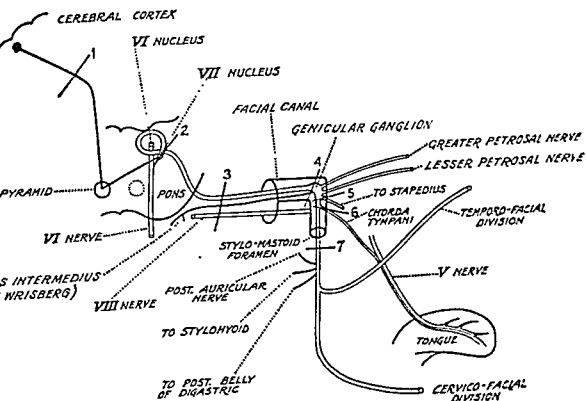


FIG. 43. DIAGRAM OF THE VII NERVE.

Lesion at 1.—Upper Motor Neurone. Paralysis of orbicularis oris. Often hemiplegia on the same side. No muscular atrophy and no R. D.

Lesion at 2.—Nuclear. Orbicularis oculi and orbicularis oris paralysed. Muscular atrophy and R. D. Hemiplegia may occur on the opposite side. VI nerve often paralysed.

Lesion at 3.—Lower motor neurone lesion of orbicularis oculi and orbicularis oris. VIII nerve also affected. Taste affected if nervus intermedius (of Wrisberg) is involved.

Lesion at 4.—Lower motor neurone lesion of orbicularis oculi and orbicularis oris. Auricular herpes. Taste may be lost on anterior two-thirds of tongue.

Lesion at 5.—Lower motor neurone lesion of orbicularis oculi and orbicularis oris. Hyperacusis and loss of taste in anterior two-thirds of tongue.

Lesion at 6.—Lower motor neurone lesion of orbicularis oculi and orbicularis oris. Loss of taste in anterior two-thirds of tongue.

Lesion at 7.—Lower motor neurone lesion of orbicularis oculi and orbicularis oris. No loss of taste.

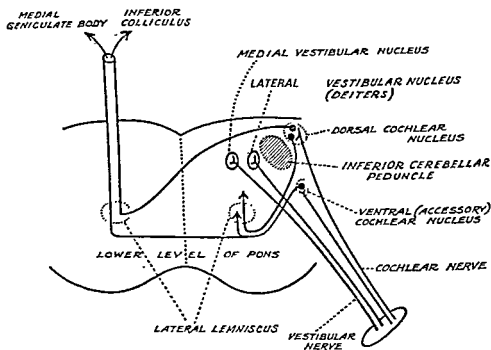


FIG. 44. DIAGRAM OF THE VIII NERVE NUCLEI.

about 80% of cases. The electrical reactions are of help in giving a prognosis. If the faradic and galvanic responses of the paralysed muscles are normal after 2 weeks, recovery will be rapid, a matter of a few weeks. If there is no response to faradism and the galvanic response shows a reaction of degeneration, recovery will not occur for several months. If no response is obtained to faradism or to galvanism, there is no likelihood of recovery. If the paralysis is due to other causes, such as a tumour, gumma or meningitis, the prognosis must vary with the nature of the lesion and the possibility of removing it by appropriate treatment.

Treatment. In the inflammatory type of case the patient should be kept in a warm room during the initial stages until all pain and tenderness have gone. Heat should be applied locally over the stylo-mastoid foramen, as by cataplasma kaolini or by fomentations. The bowels should be opened daily, and a mixture given containing: Pot. iod. 3 gr. (0.2 G.), sod. salicyl. 10 gr. (0.6 G.), sod. bicarb. 20 gr. (1.2 G.), syr. aurant. 20 m. (1.2 ml.), aq. ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s. p.c. Corticosteroids have been recommended without definite evidence of their value. Strips of strapping should be placed on the affected side of the face, one above the other below the mouth, to prevent the mouth being drawn over to the sound side. After a week, massage should be given daily to the affected muscles and later the muscles may be stimulated with a weak faradic current. In all cases the Wassermann reaction should be determined, and, if positive, a course of anti-syphilitic treatment should be given. Some surgeons advise early operation, either by decompression of the descending portion of the nerve, or by placing in the facial canal a prepared nerve graft, obtained from a cutaneous nerve of the thigh (Ballance-Duel nerve graft). The insertion of tantalum wire or ribbon in the temporal fascia, to give some support to the sagging eyelids and mouth, has caused improvement in some cases in which it has been tried. Homolateral stellate ganglion procaine hydrochloride block has also been reported on favourably.

Bilateral Facial Paralysis. This may be congenital, and there is often paralysis of the muscles supplied by the oculo-motor nerves as well. Other causes include double otitis media, basal gummatous meningitis, an aneurysm of the basilar artery, diphtheria, leprosy and alcoholic neuritis. Both sides of the face are then expressionless.

The VIII Nerve

(The Stato-acoustic or Auditory Nerve)

Anatomy. The VIII nerve consists of a cochlear and a vestibular division. The former is concerned with hearing, and the latter with equilibrium. The cochlear nerve fibres arise from cells in the spiral ganglion, situated in the central pillar of the cochlea, their peripheral terminations ending in connection with the hair cells of the organ of Corti. Centrally the cochlear nerve passes to the brain through the internal acoustic meatus, running below the VII nerve. It enters the lower border of the pons on the lateral side of the inferior cerebellar

peduncle (restiform body), and terminates around cells of the dorsal nucleus and the ventral cochlear nucleus. A fresh relay of fibres conducts the impulses across the mid-line in two strands, a dorsal or *striæ acusticæ* and a ventral or *corpus trapezoidum*. These unite to form the lateral lemniscus. Some of the fibres from the cochlear nuclei also run to the lateral lemniscus of the same side. The lateral lemniscus ascends the mid-brain and terminates in the lower auditory centres, the medial geniculate body and the inferior colliculus. The medial geniculate bodies are connected by commissural fibres. A further relay conveys the impulses through the posterior part of the internal capsule to the higher auditory centres in the superior temporal gyrus of the cerebral cortex.

The cells of origin of the vestibular nerve are in the ganglion which lies in the internal acoustic meatus. Their peripheral terminations are in the semicircular canals and the otolith organs (the utricle and saccule). The fibres from the semicircular canals convey sensations of movement (kinetic impulses), whereas those from the otolith organs transmit sensations of position (static impulses). Centrally the fibres pass with the cochlear division and enter the lower part of the pons between the inferior cerebellar peduncle and the olive, terminating around the cells of the medial vestibular nucleus and Deiters or the lateral vestibular nucleus. The upper part of the lateral vestibular nucleus constitutes the superior nucleus (see Fig. 44). The further course of the vestibular path is rather open to discussion. Fibres pass from the lateral vestibular nucleus up the pons and mid-brain in the medial longitudinal bundle. In this way connection is made with the nuclei of the oculo-motor nerves, thus establishing relationship between equilibrium and eye movements. Impulses are also carried downwards in the medial longitudinal bundle to connect with the XI nucleus and establish a relationship with equilibrium and head movements. Fibres also descend the spinal medulla (cord) in the vestibulospinal tract, whereby a connection is made between the sense of equilibrium and the tone of skeletal muscles. Some fibres of the vestibular nerve run direct to the cerebellum by the inferior cerebellar peduncle, and fibres also pass from the cerebellum in the inferior cerebellar peduncle to the lateral vestibular nucleus (see Fig. 34).

Lesions of the VIII Nerve. The VIII nerve may be affected by tumours of the cerebello-pontine angle pressing on, or growing from the nerve itself, or by basal meningitis due to syphilis or cerebrospinal fever. Neuritis may be due to toxins of typhoid or scarlet fever, to syphilis, or to such substances as alcohol, tobacco, quinine or salicylates. Atrophy may occur in *tabes dorsalis* or in multiple sclerosis. The nerve may be injured in a fracture of the base of the skull or by disease of the petrous bone. Inflammation may affect it in otitis media, labyrinthitis or catarrh of the auditory tube. It may be involved in a vascular lesion, such as a hæmorrhage or thrombosis, and by a leukæmic infiltration. Central lesions are rare. Deafness sometimes results from streptomycin injections. A bilateral lesion of the superior temporal gyrus may cause deafness, or word-deafness may result from a unilateral lesion affecting

mastoid process first on one ear and then on the other. The patient is tested against the different frequencies and presses a button, which lights a lamp, directly he hears a sound. Eight tones are produced with frequencies of 64 to 8,192 cycles per second, in octave steps. These are shown along the top of the audiogram and correspond with the musical notations of C, c, c¹, c², c³, c⁴, c⁵, c⁶, 256 being the middle C of the piano. The intensity of each tone is increased until heard by the patient, and then charted on an audiogram. In perceptive deafness there is loss of high tone, in conductive deafness loss of low tone. The frequencies 256, 512 and 1,024 are those of the ordinary speaking voice. The average of these three readings, multiplied by 0.8, gives the percentage hearing loss for the spoken voice. *Paracusis* means that the patient hears best in a noise. It is found especially in otosclerosis.

Sudden deafness. This may affect one or both ears, and is always a frightening experience for the patient, and often a difficult diagnostic problem for the doctor. The cause remains unknown in about 50% of cases. The following conditions should be considered, hæmorrhage into the labyrinth, toxic neuritis of the VIII nerve, suppurative labyrinthitis, otitic herpes, mumps deafness (usually unilateral), allergic reactions, hysteria and malingering.

Tinnitus aurium. The chief symptom complained of may be noises in the ear or head, with or without some degree of deafness. This may be due to general causes, such as anæmia, a high or low blood pressure or neurasthenia, or to local affections, especially to otosclerosis, chronic otitis media, bony overgrowth of the external meatus, wax in the ears, labyrinthine lesions or intracranial suppuration. It may occur as an aura in epilepsy, or be produced by drugs, such as quinine and salicylates. The noises may be continuous or intermittent, and of varying character, often hissing or roaring, or at times higher pitched, or pulsating in correspondence with the heart beat. In all cases a complete local examination should be made by an otologist as well as a general examination of the patient by a physician.

Treatment. This consists in local measures for relief of catarrh of the auditory tube, etc., which falls in the province of the specialist.

The Vestibular Nerve. Lesions of the vestibular nerve, or of its terminations in the semicircular canals and otolith organs, result in three main symptoms: Vertigo, postural or kinetic deviation and nystagmus.

Vertigo. The patient who complains of vertigo may say that his own body appears to be moving, or that surrounding objects are moving. Vertigo may thus be called, perhaps incorrectly, subjective or objective.

Etiology. The common causes of vertigo include: Wax in the ears, otitis media, labyrinthitis, alimentary disturbances, train, car or sea-sickness, migraine, cerebellar lesions, high blood pressure, low blood pressure, basilar artery atherosclerosis, cervical spondylosis, change of posture such as looking up, turning over in bed, or sitting up, over-smoking, alcohol and epilepsy. Vertigo may also be psychogenic associated with an anxiety state, ocular as when looking down from a

height, or due to external oculo-motor paralysis. It is sometimes met with in brain-stem lesions such as multiple sclerosis, a tumour or a vascular disturbance. A cysticercus in the IV ventricle may also produce attacks of severe vertigo. Vestibular vertigo results from irritative lesions of the ear affecting the semicircular canals. Epidemic vertigo, with uncontrollable vomiting, is also described. This may be a manifestation of influenza. Streptomycin may cause giddiness from involvement of the vestibular nerve or its nucleus. Relief may be obtained by ice-cold water-bottles applied to the occipital region, and by the administration of dextrose 1 oz. (30 G.) t.i.d. by mouth.

Postural Deviation. The patient may tend to fall towards the affected side in irritative vestibular lesions, when he stands with eyes closed and feet together.

Kinetic Deviation. This is described later (see below).

Nystagmus. Irritative labyrinthine lesions produce spontaneous vestibular nystagmus to the opposite side; i.e., the eyes make a slow movement to the same side and a rapid twitch back to the opposite side. These movements are increased when the patient looks to the side of the nystagmus (i.e., that in which the rapid movement occurs).

Clinical Findings. Certain tests are applied in suspected cases of labyrinthine lesions. These include: 1. *The Rotation Test.* The patient is placed in a special chair with a head rest, so that the head is inclined forwards 30° to the vertical plane. He is then rotated 10 times in 20 seconds and the chair stopped. Rotation is done in both directions, with a suitable interval between. On rotating to the right and stopping, normally the slow component of the nystagmus, the tendency to fall and the past-pointing (Bárány's test) are to the left, the quick component of the nystagmus and the sensation of vertigo are to the right. With rotation to the left the opposite results are found. Diminished responses on rotation to one side indicate a lesion of the opposite labyrinth.

2. *The Caloric Test.* The patient lies on a couch with the head tilted back 60° from the vertical plane. The drum is first inspected to see that it is not perforated and that the external acoustic meatus is free from wax and polypi. A douche can, holding at least one pint (600 ml.) of water, is slung so that the bottom of the can is 2 feet (60 cm.) above the head of the patient. The water is delivered through a rubber tube connected with an ear nozzle with a bore of 4 mm. Each ear is first tested with cold water at 80° F. (30° C.), and the water is delivered into the external meatus for 40 seconds, using a stop watch. The patient keeps his eyes fixed on a spot high up on the opposite wall. A normal response shows a quick nystagmus to the opposite side. The ears are next tested with hot water at 111° F. (42° C.). The normal response is the quick component of the nystagmus to the same side. An absent or diminished response on one side indicates a lesion of that labyrinth. Cold air may also be used as a stimulus, the air being blown through a metal tube cooled by a spray of ethyl chloride.

Irritative Vestibular Lesions. These are exemplified in Ménière's syndrome and in Ménière's symptom complex. *Ménière's syndrome.* The disease, originally described by Ménière, was due to an acute

labyrinthine hæmorrhage associated with acute purulent labyrinthitis, and was not typical of what we now call Ménière's disease. In some cases there is pressure on the auditory nerve caused by an aneurysm of the basilar artery, an abnormally large internal auditory artery, or by a pontocerebellar angle tumour. It is probable that only lesions affecting the vestibular division of the VIII nerve cause Ménière's disease. Some authorities believe that it may be caused by faulty water or salt metabolism resulting in a water-logged labyrinth or that the hydrops of the endolymphatic labyrinth is in some cases an allergic manifestation. The patient, who is usually an adult, is suddenly attacked with severe vertigo and falls. There may be a preliminary phase of low-pitched tinnitus. Vomiting may occur.

On Examination: The patient is usually found lying on the sound side; if he attempts to turn on his back or on the affected side, vomiting is induced. The eyes show coarse nystagmoid movements to the affected side. There may be momentary loss of consciousness. Permanent deafness usually ensues. *Ménière's symptom complex.* This may be due to vascular spasm of the internal auditory artery causing alteration in the tension of the endolymph, or to otosclerosis. The attacks resemble those of the Ménière's syndrome, but between the attacks there is no loss of hearing.

Treatment. During an acute attack an injection of hyoscin. hydrobromid. $\frac{1}{100}$ gr. (0.6 mg.) should be given. Between attacks various drugs may be tried. Quinine sulphate in doses of $\frac{1}{4}$ gr. (15 mg.) t.d.s. or phenobarbitone $\frac{1}{2}$ gr. (30 mg.) t.d.s. may be administered to diminish the sensibility of the labyrinth. In some cases relief is obtained by the administration of a salt-poor diet (see p. 482) with restriction of the fluid intake to 40 fl. oz. (1.2 litre) in the 24 hours. Ammon. chlorid. 0.5 G. tablets, 6 t.i.d. with meals, should be given for 3 days out of every five. Mersalyl 2 ml. may also be injected intramuscularly once a week. Favourable results may also ensue from the use of hydrochlorothiazide and potassium chloride (see p. 243). Promethazine chlorotheophyllinate (Avomine), tab. 25 mg. t.i.d., may be of value in some cases, and in others nicotinic acid, tab. 50 mg., 1 to 3 t.i.d., is helpful. Surgical treatment consists in division of the auditory nerve or of the vestibular branch alone, or destruction of the labyrinth. Determination of the side affected is not always easy. The tinnitus and deafness are usually more severe on one side and the caloric tests may indicate which labyrinth is at fault. Vertigo is not always, and tinnitus is rarely, relieved by the operation. Surgery should only be advised if medical treatment fails.

Acute Vestibulitis. This is due to acute inflammation of the cochlea and labyrinth. There is tinnitus, vertigo, vomiting and usually pyrexia, and it often results in permanent deafness.

longata. This nucleus is common to the IX and X nerves. The nucleus ambiguus extends through the medulla oblongata from the level of the VIII nerve above to the decussation of the lemniscus below. The sensory fibres arise from cells in the superior (jugular) and inferior (petrosal) ganglia. These ganglia lie on the nerve trunk in the jugular foramen. The sensory fibres pass into the medulla oblongata and run down it as the tractus solitarius, the fibres ending at different levels in the nucleus of the tractus solitarius which adjoins the tract (see Fig. 45). Other ascending fibres enter the dorsal nucleus and pass up the medulla oblongata. The further central course of the sensory fibres is not definitely known. It will be remembered that the fibres of the nervus intermedius (of Wrisberg) also end in the tractus solitarius (see p. 398). The sensory and motor fibres of the IX nerve enter and leave the medulla oblongata in 5 or 6 strands on the postero lateral surface between the olive and inferior cerebellar peduncle. The nerve passes through the jugular foramen with the X nerve, but in a special sheath of dura mater. It runs between the internal and external carotid arteries and then deep to the hyoglossus muscle to the pharynx.

Sensory Branches. In the skull it receives a tympanic branch from the inferior ganglion, which supplies the middle ear, the mastoid air cells and the auditory tube. It conveys taste sensation from the posterior third of the tongue and from taste buds on the soft palate, epiglottis and arytenoid cartilages. It transmits common sensation from the back of the tongue, tonsil, part of the soft palate and the upper part of the pharynx.

Motor Branches. The IX nerve supplies motor fibres to the stylopharyngeus, and secretory fibres to the parotid gland. The constrictors of the pharynx are probably supplied by the vagus.

Lesions of the IX Nerve. Nuclear lesions may be due to such causes as a tumour, a gumma, syringomyelia, multiple sclerosis, polioencephalitis, or thrombosis of the posterior inferior cerebellar artery. There is no definite pathology of central lesions.

Clinical Findings. Motor Lesions. It is probable that lower motor neurone lesions causing dysphagia are due to affections of the X nerve. A lesion paralysing the stylopharyngeus muscle may cause some dysphagia, as the larynx is not then drawn up on swallowing and food may enter the trachea.

Sensory Lesions. Loss of taste over the posterior third of the tongue, with anaesthesia of the pharynx and tonsillar region and loss of the pharyngeal reflex may result from involvement of the tractus solitarius in the medulla oblongata.

Glossopharyngeal Neuralgia. The patient is usually an adult over middle age who complains of pain, often agonising, on swallowing or talking, in the region of the pillars of the fauces on one side. The pain may shoot to the ear and disturb sleep. Pressure on the tonsil on the affected side may produce a paroxysm of pain. If the tympanic branch alone is affected, there is deep-seated pain in one ear which occurs in paroxysms, but is not aroused by swallowing.

Treatment. There is usually no treatment available for nuclear

lesions, unless due to syphilis. Glossopharyngeal neuralgia should be treated first with a gelsemium mixture, as for trigeminal neuralgia. The inhalation, while the patient lies down, of trichlorethylene 15 m. (1 ml.) t.d.s. may afford relief. This is put up as a sterule encased in cottonwool and silk. It can be broken between the fingers and the vapour inhaled. If this fails an operation should be considered. The glossopharyngeal nerve may be divided intracranially, or it may be exposed at its emergence from the jugular foramen and avulsed from its central connection with the medulla oblongata.

The X Nerve

(*The Vagus. The Pneumogastric Nerve*)

Anatomy. The vagus nerve contains motor and sensory fibres. The bulbar portion of the spinal accessory nerve is considered to be a

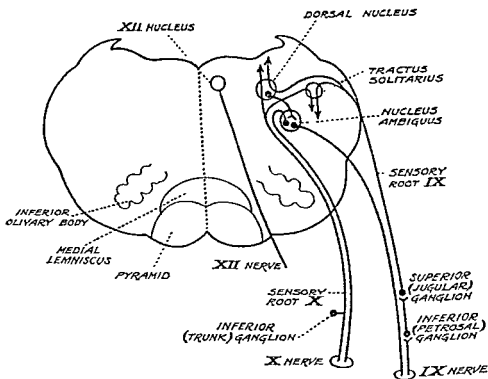


FIG. 45. DIAGRAM OF THE NUCLEI OF THE IX, X, AND XII CRANIAL NERVES.

part of the vagus nerve. The motor fibres arise from the nucleus ambiguus in the medulla oblongata (see Fig. 45). The sensory fibres are derived from cells in the inferior (trunk) ganglion which lies on the nerve just external to the skull. The sensory fibres enter the medulla oblongata and terminate in the tractus solitarius (descending) and in the dorsal nucleus (ascending) (see Fig. 45). The upper motor neurones arise in the cerebral cortex in the lower part of the precentral gyrus, and pass down in the corticonuclear tract to end around the motor nuclei of the opposite side. The vagus nerve emerges from the side of the

medulla oblongata by a series of roots in line with those of the IX nerve above. A meningeal and an auricular branch leave the nerve at the level of the superior ganglion. The latter, supplies the skin at the back of the pinna and the external acoustic meatus. The vagus leaves the skull through the jugular foramen, behind the IX nerve. Two branches arise from the inferior ganglion, the pharyngeal and the superior laryngeal nerves. The bulbar fibres of the XI nerve join the X nerve just below the inferior ganglion. The vagus runs down the neck in the carotid sheath and gives off the recurrent laryngeal branch and cardiac branches. It enters the thorax, passing between the internal carotid and subclavian arteries on the left side, and crossing in front of the subclavian artery on the right side. It then traverses the superior and posterior mediastinal spaces. In the thorax it gives rise to the pulmonary and œsophageal plexuses. The vagus enters the abdomen through the œsophageal opening of the diaphragm, the left nerve being in front of, and the right nerve behind the œsophagus. It terminates in branches to the stomach and small intestine. Motor fibres are supplied to the soft palate, the pharynx, larynx, œsophagus, stomach, small intestine, trachea and bronchi. The muscles of the palate, pharynx and larynx are probably supplied by the bulbar portion of the XI nerve. The nerve supply of the laryngeal muscles is described on p. 192.

Secretory fibres are conveyed to the stomach, small intestine and pancreas. Inhibitory fibres are carried to the heart. Sensory impulses pass by the vagus from the skin of the pinna and external acoustic meatus, and from the mucous membranes of the larynx, respiratory tract, œsophagus and stomach.

Lesions of the X Nerve. *Nuclear Lesions* may be due to progressive bulbar palsy, syringomyelia, encephalitis lethargica, rabies, thrombosis, multiple sclerosis, or syphilis. The nerve may be injured at various sites, such as: (a) *In the skull.* This may be due to basal meningitis, especially syphilitic, a tumour, an aneurysm of the vertebral artery, or a fractured base. (b) *In the neck.* The lesion may be due to a wound, a tumour or to damage at an operation. (c) *In the thorax.* An aneurysm, a mediastinal tumour, or enlarged lymph nodes may compress the nerve.

The vagus nerve may be affected by neuritis, especially in diphtheria. Less often the neuritis is due to typhoid fever, influenza, pneumonia, or to chemicals, such as alcohol or arsenic.

Clinical Findings. (a) *Irritative Lesions.* Irritation of the vagus in the mediastinum by enlarged lymph nodes or a tumour may cause an intractable cough somewhat resembling whooping-cough. Attacks of laryngeal spasm, as in the laryngeal crises of tabes, may be due to central lesions. Reflex laryngeal spasm also occurs in such conditions as laryngismus stridulus. Irritation of the vagus may also cause hyperæsthesia of the posterior wall of the external acoustic meatus. Touching the skin in this area may provoke cough (the *tragus sign*). Some instances of dyspnoea on slight exertion or of bradycardia may be due to vagal stimulation, and some cases of asthma are thought to be associated with undue irritability of the broncho-motor portion of the

lesions, unless due to syphilis. Glossopharyngeal neuralgia should be treated first with a gelsemium mixture, as for trigeminal neuralgia. The inhalation, while the patient lies down, of trichlorethylene 15 m. (1 ml.) t.d.s. may afford relief. This is put up as a sterule encased in cottonwool and silk. It can be broken between the fingers and the vapour inhaled. If this fails an operation should be considered. The glossopharyngeal nerve may be divided intracranially, or it may be exposed at its emergence from the jugular foramen and avulsed from its central connection with the medulla oblongata.

The X Nerve

(*The Vagus. The Pneumogastric Nerve*)

Anatomy. The vagus nerve contains motor and sensory fibres. The bulbar portion of the spinal accessory nerve is considered to be a

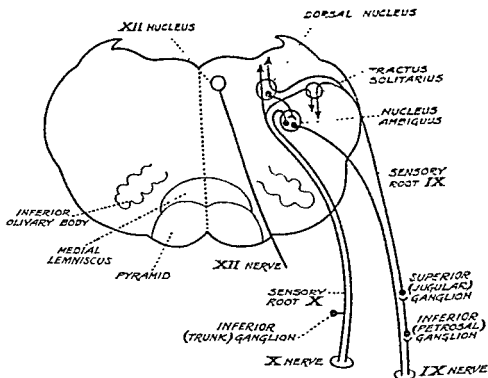


FIG. 45. DIAGRAM OF THE NUCLEI OF THE IX, X, AND XII CRANIAL NERVES.

part of the vagus nerve. The motor fibres arise from the nucleus ambiguus in the medulla oblongata (see Fig. 45). The sensory fibres are derived from cells in the inferior (trunk) ganglion which lies on the nerve just external to the skull. The sensory fibres enter the medulla oblongata and terminate in the tractus solitarius (descending) and in the dorsal nucleus (ascending) (see Fig. 45). The upper motor neurones arise in the cerebral cortex in the lower part of the precentral gyrus, and pass down in the corticonuclear tract to end around the motor nuclei of the opposite side. The vagus nerve emerges from the side of the

lesions : The sternocleidomastoid or trapezius muscles may be paralysed individually or together. With unilateral sternocleidomastoid paralysis the patient does not notice any weakness.

On Examination : No deformity is visible, but if the patient is asked to turn his head away from the affected side while the examiner's hand is held against his chin on the sound side, the sternocleidomastoid muscle does not contract and stand out on the affected side. If both sternocleidomastoids are paralysed the head is inclined to fall backwards. When the trapezius on one side is paralysed the patient notices difficulty in raising the corresponding arm above the horizontal, in shrugging the shoulder or in causing the scapula to approach the mid-line. There is drooping of the shoulder on the affected side. The scapula is in an abnormal position, being farther from the mid-line and lower than normal, and rotated outwards. The vertebral border is prominent and runs from below upwards and outwards ; this is known as "winging" of the scapula and is best seen when the arm is held forwards and below the horizontal level. When the patient tries to shrug his shoulders or to approximate the scapulæ, the trapezius muscle can be seen and felt to remain uncontracted on one side. If both trapezii are paralysed the head is inclined to fall forwards. Fibrillary twitchings may be seen in the paralysed muscles which also give a reaction of degeneration.

The XII Nerve

(The Hypoglossal Nerve)

Anatomy. The nucleus of origin is situated in the medulla oblongata, extending from the level of the hypoglossal triangle of the floor of the fourth ventricle above to the pyramidal decussation below (see Fig. 45). The nerve fibres leave the medulla oblongata between the pyramid and the olive in a series which unite to form three roots. These join and the hypoglossal nerve leaves the skull through the anterior condylar foramen. The nerve passes between the internal carotid artery and the internal jugular vein, and forming connections with the first and second cervical nerves, reaches the floor of the mouth to supply the intrinsic and extrinsic muscles of the tongue.

Lesions of the XII Nerve. The lesions may be: 1. *Supranuclear.* These are usually vascular, in the cerebral cortex or internal capsule. 2. *Nuclear.* Various lesions may be found, such as those due to progressive bulbar paralysis, syringobulbia, polioencephalitis, multiple sclerosis, thrombosis, a gumma or a tumour. 3. *At the base of the brain.* The nerve roots may be affected by a tumour, by meningitis, an aneurysm of the vertebral artery, or a fractured base. 4. *In the hypoglossal canal.* Periostitis may cause compression of the nerve. 5. *In the neck.* Enlarged lymph nodes or caries of the first cervical vertebra.

Clinical Findings. 1. *Upper Motor Neurone Lesions.* There is weakness and spasticity of the affected half of the tongue. On protrusion it deviates towards the paralysed side. There is usually hemiplegia of the same side of the body.

2. *Lower Motor Neurone Lesions.* Nuclear lesions are often bilateral, as in progressive bulbar palsy. There is difficulty in chewing and

vagus nucleus. Irritation of the pharyngeal fibres of the vagus may account for the dysphagia in hydrophobia or in hysteria. Similarly the gastric crises of tabes may be due to irritation of the gastric branches of the vagus.

(b) *Paralytic Lesions.* Paralysis of the vagus nerve on one side results in anæsthesia and paralysis of the palate and larynx on the same side (the syndrome of Avellis). The palatal paralysis is detected by inspecting the palate when the patient says "ah." The raphe of the palate and the uvula then deviate to the sound side. The oculo-cardiac reflex is also usually abolished on that side. This is tested by pressing on the eyeball with the eyelid closed. Normally the pulse rate should slow by about 10 to 20 beats a minute. With a vagal paralysis this reflex slowing may be absent. With bilateral lesions affecting the palate, there is usually nasal regurgitation and a nasal voice. With pharyngeal paralysis there is dysphagia and liquids often enter the larynx and provoke cough. The effects of paralysis of the laryngeal branches of the vagus are described on p. 132.

The XI Nerve

(The Accessory Nerve)

Anatomy. The bulbar portion of this nerve has been described above under the X nerve, of which it constitutes a part. The spinal portion is motor in function, and arises from a column of cells in the lateral part of the anterior grey column of the spinal cord, from the first to the fifth cervical segments. The nerve fibres emerge between the ventral and dorsal nerve roots, and joining to form the XI nerve, ascend by the side of the cord in the subdural space to the foramen magnum. It is here joined by the bulbar portion of the nerve, which again shortly leaves it to pass to the vagus nerve just below the inferior ganglion. The XI nerve leaves the skull through the jugular foramen with the X nerve, and passes between the internal carotid artery and the internal jugular vein. It then runs backwards through the sternocleidomastoid muscle, leaving its posterior border at the level of the junction of its upper and middle thirds. It finally crosses the posterior triangle of the neck to the under surface of the trapezius muscle. The XI nerve supplies the sternocleidomastoid and part of the trapezius muscles. The trapezius is supplied in its upper part by the XI nerve and to a lesser degree in its lower part, the central portion being innervated by the subtrapezial plexus from the 3rd and 4th cervical nerves.

Lesions of the XI Nerve. 1. *Nuclear*, as in progressive muscular atrophy, multiple sclerosis, syringomyelia or myelitis. 2. *At the base of the brain*, the lesion being due to meningitis, aneurysm of the vertebral artery, or a fractured base. 3. *In the neck.* Trauma by lifting heavy weights or by a wound. Injury during an operation on lymph nodes. Cervical caries. Neuritis is not a common cause.

Clinical Findings. Irritative lesions of the XI nerve or of its supranuclear connections may cause spasmodic torticollis. Paralytic

the underlying brain substance. The vascular changes consist of endarteritis obliterans, whereby the blood supply is cut off from portions of the brain with consequent softening, hæmorrhages, or the formation of cysts.

Clinical Findings. The patient may give a history of syphilitic infection 4 or 5 years previously. He complains of headache, which is often worse at night, the memory deteriorates, and transient pareses of the limbs or double vision may occur.

In *cortical meningitis* there may be epileptiform convulsions affecting one or more limbs, and during the attacks the patient may or may not lose consciousness.

In *basal meningitis* various cranial nerve lesions can be detected, such as optic neuritis, unequal, irregular or fixed pupils, ptosis, weakness of the external ocular muscles, pains in the face, deafness, weakness of one side of the tongue, or unilateral vocal cord paralysis.

A *cerebral gumma* gives rise to the signs of a cerebral tumour, there is optic neuritis, and often vomiting, with headache.

Syphilitic dementia may occur in meningo-vascular syphilis, the symptoms closely resemble those of general paralysis, but there is usually evidence of some cranial nerve lesion.

Spinal Syphilis

Pathology. The dura may be much thickened, especially in the cervical region, giving rise to pachymeningitis cervicalis hypertrophica. There is usually compression of the cervical nerve roots. In other cases there is a gummatous infiltration of the pia-arachnoid, especially in the thoracic region. The pia becomes adherent to the cord and the vascular supply of the spinal medulla (cord) is interfered with. A condition of meningo-myelitis then results. Thrombosis or a hæmorrhage in the spinal medulla (cord) will give rise to acute syphilitic myelitis. A gumma may also form, with symptoms of a spinal medulla (cord) tumour.

Clinical Findings. *Pachymeningitis Cervicalis Hypertrophica.* The patient complains of severe pains in the neck and upper part of the back and arms, with weakness of the arm muscles.

On Examination: There is wasting of the arm muscles, with diminution of the deep reflexes and some loss of cutaneous sensation.

Chronic Meningo-myelitis. The patient complains of pain in the back, usually in the thoracic region, with weakness and numbness of the legs and often loss of sphincter control.

On Examination: Signs of a lesion of the spinal medulla (cord) in the thoracic region are found. Thus there is weakness of the legs or paraplegia, with spasticity of the leg muscles and increase of the deep reflexes. The plantar responses are extensor. The abdominal reflexes are lost below the site of the lesion. There is some diminution of sensation or anæsthesia over the legs and lower half of the body below the lesion. The disease runs a course usually lasting a few months, when, with suitable treatment, recovery may gradually take place.

swallowing and in speech. The lips and palate are often affected as well. The lesion may involve one or other corticospinal tract, with hemiplegia. The tongue lies flaccid and shrivelled on the floor of the mouth.

With Unilateral Lesions. The affected half of the tongue is small and shrivelled. On protrusion the tongue deviates to the weakened side. Fibrillary contractions may be seen on the affected side of the tongue, and a reaction of degeneration may be present. Speech is not usually affected.

SYPHILIS OF THE NERVOUS SYSTEM

Introductory. The incidence of neuro-syphilis has fallen considerably during the last 20 years or so. Syphilitic lesions of the central nervous system are usually divided into two groups, meningo-vascular (interstitial) and parenchymatous. The former includes such clinical conditions as meningitis, meningo-encephalitis, meningo-myelitis, cerebral and spinal gumma, cerebral syphilis and spinal syphilis, and the latter group embraces general paralysis of the insane and tabes dorsalis. The distinction is, however, somewhat artificial, as the primary cerebral lesion in either case is invariably an arteritis or a lymphangitis. Thus the meninges and vessels are affected predominantly in meningo-vascular syphilis, but in general paralysis of the insane and in tabes lesions can be demonstrated at autopsy in the vessels and meninges, and during life the cerebrospinal fluid shows a meningeal reaction (increase of cells, etc.).

The nervous system is believed to be infected during the primary or secondary stages of syphilis in cases which subsequently develop neuro-syphilis, although not every case so infected shows signs later of neuro-syphilis. Actually there is evidence of infection of the nervous system in many cases of syphilis during the primary and secondary stages. Thus there may be headache, giddiness and some disturbance of vision. The cerebrospinal fluid shows an increase of cells, up to 100 per c.mm., globulin may be present, and treponemes found in the fluid. The Wassermann reaction is also at times positive in the fluid before it is so in the blood, and a luetic curve is obtained with Lange's test (see Fig. 26). In the majority of cases these changes are transitory, but the treponemes may lie dormant and after 4 or 5 years another meningeal reaction occur, with clinical evidence of neuro-syphilis.

Meningo-vascular Syphilis

The lesions may affect chiefly the brain or the spinal medulla (cord).

Cerebral Syphilis

Pathology. The meninges may be chiefly affected, the pia-arachnoid being involved in a gummatous infiltration. The base of the brain is a favourite site, and various cranial nerves may be affected. In other cases the lesion is cortical. Small or large gummata form and compress

Erb's Syphilitic Paralysis. This usually develops insidiously several years after infection; there is spasticity of the legs, without marked changes of sensation.

Acute Transverse Myelitis. The patient is suddenly taken ill with weakness or paralysis of the legs and loss of sphincter control. The signs closely resemble those described above for meningo-myelitis, but the paralysis is usually of a flaccid type in the early stages, with loss of deep reflexes and of the plantar response. Later a spastic paralysis may ensue with exaggerated tendon reflexes and extensor plantar responses. A zone of hyperæsthesia is usually found running round the body at the skin level corresponding with the site of the lesion in the spinal medulla (cord). In both these varieties there is often evidence of some intracranial involvement, such as headache, giddiness and weakness of the external ocular muscles.

Differential Diagnosis. The effects produced by meningo-vascular syphilis may, and often do, closely simulate many diseases of the nervous system, such as epilepsy, Jacksonian epilepsy, a cerebral tumour, meningitis due to other causes, general paralysis, tabo-paresis, multiple sclerosis, progressive muscular atrophy, etc. The presence of cranial nerve palsies is always suggestive of a syphilitic infection. The diagnosis is established by the results of the examination of the blood and of the cerebrospinal fluid. The blood Wassermann reaction is nearly always positive and the cerebrospinal fluid shows a positive Wassermann reaction, increase of cells, the presence of globulin and often a meningitic curve (see Fig. 26).

Prognosis. This is most hopeful when the lesions are meningeal rather than vascular.

Treatment. Penicillin is now the sheet anchor of treatment, bismuth and malaria are seldom used. The first injection should be small, 1,500 units (0.9 mg.) of benzylpenicillin intramuscularly t.i.d., to avoid provoking a Jarish-Herxheimer focal reaction (see p. 600). Subsequently the dose is increased to 60,000 units (36 mg.) every 3 hours for 24 hours, then to 100,000 units (60 mg.) every 3 hours for 24 hours, and then to 500,000 units (300 mg.) of benzylpenicillin or 600,000 units of procaine penicillin every 12 hours for 10 to 12 days. Some authorities advise that 1 million units (600 mg.) of benzylpenicillin should be given daily for 10 days, others say that the penicillin should be covered by giving prednisone by mouth the day before and two days after the first injection of penicillin. The penicillin eradicates the treponemes from the cerebral nervous system, but to deal with the inflammatory products it is wise to give an iodide and mercury mixture during the penicillin treatment and for 3 to 4 weeks after. The mixture contains Pot. iod. 10 gr. (0.6 G.), liq. hydrarg. perchlor. 30 m. (2 ml.), liq. arsenical. 2 m. (0.12 ml.), aq. chlorof. ad $\frac{1}{2}$ fl. oz. (15 ml.), $\frac{1}{2}$ fl. oz. (15 ml.) ex aq. t.d.s. p.c. A lumbar puncture should be performed after 3 months. If there are more than 4 lymphocytes per c.mm. a second course of penicillin is given. If the cell count remains below 4 lymphocytes for 6 months, it is not likely to rise again.

such as the knee, hip, ankle, elbow or shoulder, are usually affected. The X-ray of the joints may show atrophy or some hypertrophy of bone. Later the patient may become very ataxic, standing on a wide base and requiring two sticks to walk, and often throwing up the legs and bringing them down in a stamping manner, heel first. Still later he may become paralysed and bed-ridden. The blood: The Wassermann reaction is positive in about 70% of early cases. The cerebrospinal fluid: Changes are found early in the disease and are of great diagnostic importance. The Wassermann reaction is positive in about 70 to 90% of early cases. The colloidal gold curve (Lange's test) gives a luetic response (see Fig. 26) in about 85% of cases. This is not diagnostic of tabes, but differs from the paretic curve. The cells are increased to about 80 per c.mm., there being a pleocytosis in nearly 100% of cases. Globulin is present (Nonne-Apert test) in about 90% of cases. In a few active cases the spinal fluid is normal.

Differential Diagnosis. As the most hopeful results are to be expected if treatment is applied early, the diagnosis should not be delayed until the disease is firmly established as shown by absent knee-jerks, an Argyll Robertson pupil and marked ataxia. In the early stages peripheral neuritis due to diabetes mellitus or alcohol may be mistaken for tabes. The urine should be tested for sugar in every case. The pains in the limbs may be considered to be rheumatic. The gastric crises closely simulate an acute abdominal lesion, and if other signs of tabes are not looked for, an unnecessary operation may be performed. A condition resembling the Argyll Robertson pupil may also be met with in encephalitis lethargica, and in alcoholic neuritis, but the pupils here are often neither small nor irregular and the reaction to accommodation is also defective.

The tonic pupil with absent tendon reflexes was first described by Markus in 1905. In 1931 Adie drew attention to this condition, and it is often known as the Adie syndrome. The pupil change is unilateral in about 80% of cases, women are more frequently affected than men, the onset being generally in the third decade. The reaction to light is usually completely absent, although if the patient is kept in a dark room a sluggish reaction can sometimes be obtained. The contraction of the pupil on accommodation is often somewhat sluggish, but the pupil becomes smaller than does the pupil in the other eye. After relaxation of the accommodation effort, re-dilatation is often slow, the pupil taking several minutes to attain its original size. Markus further showed that the pupil reacts to accommodation and not to convergence. The ankle-jerks, knee-jerks and the arm-jerks are absent in many cases. The cause is unknown.

Difficulty in walking may occur in multiple sclerosis, but here the plantar response is extensor and this also applies to Friedreich's ataxia. In cerebellar ataxia there is usually nystagmus, and the ataxy is not increased when the eyes are shut. Syphilitic meningo-myelitis may closely simulate tabes, but the course is usually more acute.

Course and Complications. The course is very variable, and the disease may be arrested at any stage, whereas an acute intercurrent

beginning, or less often of frequency or incontinence. Impotence may also be an early symptom. In other cases pains have been noticed, either prolonged muscular ones, which are probably described as rheumatic, or sharp agonising "lightning" pains, occurring in attacks of sharp stabs. These are often felt near the lateral side of the knee, in the calf, heel or foot, or the pains may run up and down the leg. In other cases the first symptom is dimness of vision or transient diplopia, or there may be complaints of difficulty in walking, the foot appearing to catch in the ground, or unsteadiness may be noted, especially in the dark or when the eyes are closed as in washing the face. Numbness, tingling, or sensations of cold may be felt in the legs or trunk, or a sense of constriction or pain around the trunk, often at the level of the upper part of the abdomen (girdle sensation). Various tabetic crises may cause distress. Very acute pain may occur in the epigastrium, with nausea, vomiting and faintness or even hæmatemesis (gastric crises). Intestinal crises are characterised by attacks of diarrhoea, rectal crises by tenesmus, vesical and renal crises by suprapubic pain and frequency, urethral crises by pain in the urethra, nasal crises by sneezing, and laryngeal or bronchial crises by dyspnoea and cough. Præcordial pain may occur with cardiac crises.

On Examination: The physical signs found in an early case are very variable and few cases pass through clearly defined pre-ataxic, ataxic and paralytic stages. The ankle-jerks are lost early. Areas of altered cutaneous sensation may be detected, such as patches of anæsthesia to the pin prick, light touch or temperature, especially over the tibiae, the perineum, the inner side of the arms, the tip of the nose or on the chest from the level of the second costal cartilage to the xiphoid process. There may be definite delay in appreciating painful stimuli. Hyperæsthesia to light touch may be present, especially over the trunk. The bone vibration sense may be lost in the feet or legs. The pupils may show the Argyll Robertson sign, being small and the reaction to light being lost, while that to accommodation persists. The pupils may be irregular, unequal and pin point in size. Ataxia may be demonstrated by asking the patient to stand with his feet and toes together and eyes shut. The patient may sway or fall (Romberg's sign) and should be carefully watched during the test. In a less advanced stage he is unable to stand on one foot with his eyes shut, or to walk along a line with his eyes open, placing one foot in front of the other. In cervical tabes the arms are chiefly affected and the patient cannot touch the tip of his nose with one finger, with his eyes closed. Pressure over the tendo calcaneus (Achillis), Abadie's sign, or over the ulnar nerve (Biernacki's sign) may not cause pain. Optic atrophy may be an early sign, the discs being pearly white. The lateral rectus muscles may be weak so that there is strabismus or diplopia, and weakness of the levator palpebræ superioris may result in ptosis. The tone of the leg muscles may be much diminished and the joint ligaments lax so that the knee can be hyperextended and the hip hyperflexed. Trophic changes, such as a perforating ulcer on the sole of the foot, or painless swellings of joints, may occur. The latter constitute Charcot's arthropathy. Large joints,

granular and rough (*langue du chat*). The amount of cerebrospinal fluid is increased. The grey matter is seen on section to be diminished. Microscopically treponemes may be found, especially in the frontal poles. The cortical pyramidal cells are degenerated. There is a cortical perivascular infiltration with lymphocytes and plasma cells, especially in the frontal lobes and to a lesser degree in the mid-brain and cerebellum. The neuroglial cells are proliferated. Syphilitic lesions in other parts of the body are not often found.

Clinical Findings. A history of syphilitic infection about 10 or 15 years previously may or may not be obtainable. In the early stages the patient may complain of headache or of a sensation of oppression on the top of the head, with insomnia. Those who know the patient best will first detect alteration in his character, such as lack of attention to details, failing memory, passion, emotion, deterioration of judgment and intellect, carelessness in habits or in dress, and possibly laxity of morals. Various delusions may occur, such as those of grandeur, wealth, excessive health, accomplishments, or marked depression. Epileptiform convulsions may occur or congestive attacks of an apoplectic type followed by hemiplegia or monoplegia, which gradually pass off.

On Examination: The pupils are usually unequal and irregular, and they often show the Argyll Robertson condition, reacting to accommodation but not to light. Tremors are seen in the lips and tongue. The tone of the facial muscles diminishes, so that wrinkles disappear. Tremors may also be seen in the hands. The speech is altered so that it is hesitating or slurred, and consonants such as the linguals and dentals are indistinct. If the patient is asked to write, the words are shaky and certain syllables are omitted. Gradually the gait becomes unsteady and the legs are weak. The tendon reflexes are exaggerated in the early stages, but later the knee-jerks and ankle-jerks may be lost. The plantar response is usually flexor, but later it may become extensor. At this stage there is a spastic paresis of the legs and the sphincter control of the bladder and rectum may be lost. In the terminal stage the patient is bed-ridden and trophic changes, such as bedsores, are likely to develop. Some degree of optic atrophy is not uncommon. The blood: The Wassermann reaction is positive in nearly 100% of cases. The cerebrospinal fluid: The fluid is clear. The pressure is slightly increased. The cells are increased to about 50 to 100 lymphocytes per c.mm. Large mononuclears or plasma cells may also be present. The Nonne-Apelt test for globulin is positive. The Lange colloidal gold test gives a typical parietic curve (see Fig. 26). The Wassermann reaction is positive in about 95 to 100% of cases.

Differential Diagnosis. In the early stages general paralysis may be mistaken for a functional disorder of the nervous system, such as neurasthenia. Cerebral syphilis is characterised by involvement of certain of the cranial motor nerves. In chronic alcoholic dementia the pupils may not react to light and there are marked tremors, but the examination of the cerebrospinal fluid serves to differentiate. A frontal lobe tumour of the brain may also cause difficulty in diagnosis,

illness may accelerate its progress. In the elderly it tends to run a benign course. Optic atrophy usually means that the patient will be blind in a few years. Complications include cystitis and pyelonephritis. Dislocation of the hip may result from atrophy of the head of the femur. General paralysis of the insane sometimes occurs as a complication.

Prognosis. This is very variable. Death may rapidly ensue, the patient wasting and becoming bedridden, or developing some complication, such as an intercurrent disease or infection of the urinary tract. In other cases the disease is arrested for long periods.

Treatment. A preliminary period of rest in bed for a few weeks is always of value. A course of treatment similar to that described on p. 414 for meningo-vascular syphilis should be given. Ataxia can be improved by having the soles of the shoes weighted, and the patient can be trained to regulate his movements by means of his eyes, by Fraenkel's exercises. The patient practises placing his feet in certain positions and on certain marks, both when he is lying and on standing. When the disease is arrested or "burned out" the cerebrospinal fluid usually shows an absence of globulin, and no colloidal gold curve, and the cell count is low; the Wassermann reaction is usually negative. Gastric crises may be treated by the subcutaneous injection of 1 ml. of inject. adrenaline (B.P.) 1 in 1,000. If relief is not obtained an intravenous injection of 5 ml. of 10% calcium gluconate or of atropin. sulph. 1/100 gr. (0.6 mg.) may prove successful. Laryngeal crises can generally be relieved by an inhalation of 5 m. (0.3 ml.) of amyl nitrite. For the "lightning" pains phenazone 10 gr. (0.6 G.) may be given. If the bladder is not completely emptied an antibiotic such as benzylpenicillin tab. B.P., 250,000 units (250 mg.), 1 tab. b.i.d. should be given from time to time to prevent cystitis. Catheterization is now seldom used. If the urine is alkaline it is advisable to give acid sodium phosphate 60 gr. (3.6 G.) at night to render it acid. A Charcot's joint should be kept at rest in a splint.

General Paralysis of the Insane

(*Dementia Paralytica*)

Definition. A disease characterised by progressive deterioration of the mind, with paralysis.

Etiology. *Dementia paralytica* is caused by infection with the *Treponema pallidum*. The infection is usually acquired, but congenital syphilis may give rise to juvenile general paralysis. **Predisposing causes:** 1. Age: Usually between 30 and 50 years. 2. Sex: Males predominate. Mental worry or brain work may also predispose.

Pathology. The body generally is wasted at autopsy. The skull cap is thickened. The dura mater is dense and hæmorrhagic pachymeningitis may be present. The arachnoid is thickened and the pia mater is adherent at places to the brain, so that on stripping it off, small portions of brain are removed with it. The brain is atrophied, the left hemisphere being affected more than the right in right-handed people. The gyri are flattened, the sulci are deepened, and the ventricles are dilated and the fourth ventricle is enlarged.

granular and rough (*langue du chat*). The amount of cerebrospinal fluid is increased. The grey matter is seen on section to be diminished. Microscopically treponemes may be found, especially in the frontal poles. The cortical pyramidal cells are degenerated. There is a cortical perivascular infiltration with lymphocytes and plasma cells, especially in the frontal lobes and to a lesser degree in the mid-brain and cerebellum. The neuroglial cells are proliferated. Syphilitic lesions in other parts of the body are not often found.

Clinical Findings. A history of syphilitic infection about 10 or 15 years previously may or may not be obtainable. In the early stages the patient may complain of headache or of a sensation of oppression on the top of the head, with insomnia. Those who know the patient best will first detect alteration in his character, such as lack of attention to details, failing memory, passion, emotion, deterioration of judgment and intellect, carelessness in habits or in dress, and possibly laxity of morals. Various delusions may occur, such as those of grandeur, wealth, excessive health, accomplishments, or marked depression. Epileptiform convulsions may occur or congestive attacks of an apoplectic type followed by hemiplegia or monoplegia, which gradually pass off.

On Examination: The pupils are usually unequal and irregular, and they often show the Argyll Robertson condition, reacting to accommodation but not to light. Tremors are seen in the lips and tongue. The tone of the facial muscles diminishes, so that wrinkles disappear. Tremors may also be seen in the hands. The speech is altered so that it is hesitating or slurred, and consonants such as the linguals and dentals are indistinct. If the patient is asked to write, the words are shaky and certain syllables are omitted. Gradually the gait becomes unsteady and the legs are weak. The tendon reflexes are exaggerated in the early stages, but later the knee-jerks and ankle-jerks may be lost. The plantar response is usually flexor, but later it may become extensor. At this stage there is a spastic paresis of the legs and the sphincter control of the bladder and rectum may be lost. In the terminal stage the patient is bed-ridden and trophic changes, such as bedsores, are likely to develop. Some degree of optic atrophy is not uncommon. The blood: The Wassermann reaction is positive in nearly 100% of cases. The cerebrospinal fluid: The fluid is clear. The pressure is slightly increased. The cells are increased to about 50 to 100 lymphocytes per c.mm. Large mononuclears or plasma cells may also be present. The Nonne-Apelt test for globulin is positive. The Lange colloidal gold test gives a typical parietic curve (see Fig. 26). The Wassermann reaction is positive in about 95 to 100% of cases.

Differential Diagnosis. In the early stages general paralysis may be mistaken for a functional disorder of the nervous system, such as neurasthenia. Cerebral syphilis is characterised by involvement of certain of the cranial motor nerves. In chronic alcoholic dementia the pupils may not react to light and there are marked tremors, but the examination of the cerebrospinal fluid serves to differentiate. A frontal lobe tumour of the brain may also cause difficulty in diagnosis,

illness may accelerate its progress. In the elderly it tends to run a benign course. Optic atrophy usually means that the patient will be blind in a few years. Complications include cystitis and pyelonephritis. Dislocation of the hip may result from atrophy of the head of the femur. General paralysis of the insane sometimes occurs as a complication.

Prognosis. This is very variable. Death may rapidly ensue, the patient wasting and becoming bedridden, or developing some complication, such as an intercurrent disease or infection of the urinary tract. In other cases the disease is arrested for long periods.

Treatment. A preliminary period of rest in bed for a few weeks is always of value. A course of treatment similar to that described on p. 414 for meningo-vascular syphilis should be given. Ataxia can be improved by having the soles of the shoes weighted, and the patient can be trained to regulate his movements by means of his eyes, by Fraenkel's exercises. The patient practises placing his feet in certain positions and on certain marks, both when he is lying and on standing. When the disease is arrested or "burned out" the cerebrospinal fluid usually shows an absence of globulin, and no colloidal gold curve, and the cell count is low; the Wassermann reaction is usually negative. Gastric crises may be treated by the subcutaneous injection of 1 ml. of inject. adrenaline (B.P.) 1 in 1,000. If relief is not obtained an intravenous injection of 5 ml. of 10% calcium gluconate or of atropin. sulph. 1/100 gr. (0.6 mg.) may prove successful. Laryngeal crises can generally be relieved by an inhalation of 5 m. (0.3 ml.) of amyl nitrite. For the "lightning" pains phenazone 10 gr. (0.6 G.) may be given. If the bladder is not completely emptied an antibiotic such as benzylpenicillin tab. B.P., 250,000 units (250 mg.), 1 tab. b.i.d. should be given from time to time to prevent cystitis. Catheterization is now seldom used. If the urine is alkaline it is advisable to give acid sodium phosphate 60 gr. (3.6 G.) at night to render it acid. A Charcot's joint should be kept at rest in a splint.

General Paralysis of the Insane

(*Dementia Paralytica*)

Definition. A disease characterised by progressive deterioration of the mind, with paralysis.

Etiology. *Dementia paralytica* is caused by infection with the *Treponema pallidum*. The infection is usually acquired, but congenital syphilis may give rise to juvenile general paralysis. **Predisposing causes:** 1. Age: Usually between 30 and 50 years. 2. Sex: Males predominate. Mental worry or brain work may also predispose.

Pathology. The body generally is wasted at autopsy. The skull cap is thickened. The dura mater is dense and hæmorrhagic pachymeningitis may be present. The arachnoid is thickened and the pia mater is adherent at places to the brain, so that on stripping it off, small portions of brain are removed with it. The brain is atrophied, the left hemisphere being more affected than the right in right-handed people. The gyri are flat and the sulci wide but shallow. The ventricles are dilated and the ependyma lining the floor of the fourth ventricle is

granular and rough (*langue du chat*). The amount of cerebrospinal fluid is increased. The grey matter is seen on section to be diminished. Microscopically treponemes may be found, especially in the frontal poles. The cortical pyramidal cells are degenerated. There is a cortical perivascular infiltration with lymphocytes and plasma cells, especially in the frontal lobes and to a lesser degree in the mid-brain and cerebellum. The neuroglial cells are proliferated. Syphilitic lesions in other parts of the body are not often found.

Clinical Findings. A history of syphilitic infection about 10 or 15 years previously may or may not be obtainable. In the early stages the patient may complain of headache or of a sensation of oppression on the top of the head, with insomnia. Those who know the patient best will first detect alteration in his character, such as lack of attention to details, failing memory, passion, emotion, deterioration of judgment and intellect, carelessness in habits or in dress, and possibly laxity of morals. Various delusions may occur, such as those of grandeur, wealth, excessive health, accomplishments, or marked depression. Epileptiform convulsions may occur or congestive attacks of an apoplectic type followed by hemiplegia or monoplegia, which gradually pass off.

On Examination: The pupils are usually unequal and irregular, and they often show the Argyll Robertson condition, reacting to accommodation but not to light. Tremors are seen in the lips and tongue. The tone of the facial muscles diminishes, so that wrinkles disappear. Tremors may also be seen in the hands. The speech is altered so that it is hesitating or slurred, and consonants such as the linguals and dentals are indistinct. If the patient is asked to write, the words are shaky and certain syllables are omitted. Gradually the gait becomes unsteady and the legs are weak. The tendon reflexes are exaggerated in the early stages, but later the knee-jerks and ankle-jerks may be lost. The plantar response is usually flexor, but later it may become extensor. At this stage there is a spastic paresis of the legs and the sphincter control of the bladder and rectum may be lost. In the terminal stage the patient is bed-ridden and trophic changes, such as bedsores, are likely to develop. Some degree of optic atrophy is not uncommon. The blood: The Wassermann reaction is positive in nearly 100% of cases. The cerebrospinal fluid: The fluid is clear. The pressure is slightly increased. The cells are increased to about 50 to 100 lymphocytes per c.mm. Large mononuclears or plasma cells may also be present. The Nonne-Apelt test for globulin is positive. The Lange colloidal gold test gives a typical parietic curve (see Fig. 26). The Wassermann reaction is positive in about 95 to 100% of cases.

Differential Diagnosis. In the early stages general paralysis may be mistaken for a functional disorder of the nervous system, such as neurasthenia. Cerebral syphilis is characterised by involvement of certain of the cranial motor nerves. In chronic alcoholic dementia the pupils may not react to light and there are marked tremors, but the examination of the cerebrospinal fluid serves to differentiate. A frontal lobe tumour of the brain may also cause difficulty in diagnosis,

but usually signs of increased intracranial pressure develop, such as optic neuritis or vomiting, and the cerebrospinal fluid does not show the changes characteristic of general paralysis.

Course and Complications. The course in an untreated case is progressive, but remissions may occur. In some instances signs of tabes also develop, the disease then being known as tabo-paresis.

Prognosis. If untreated, death usually takes place within 4 years of diagnosis. If the disease is arrested by treatment in the early stages, the patient may be restored to health so that he is able to resume his work. If arrest occurs in the later stages, the patient closely resembles an animal with a very low grade intellect; speech is difficult to understand, he is childish and very emotional and requires constant attention.

Treatment. Penicillin should be given as described for meningo-vascular syphilis (see p. 414).

DISEASES OF THE MOTOR NEURONES

Motor Neurone Disease

Introductory. A group of diseases is included under this heading, such as: Progressive ophthalmoplegia, progressive bulbar paralysis, progressive muscular atrophy, amyotrophic lateral sclerosis, and primary lateral sclerosis. In all of them the lesion consists of a chronic degeneration of the cells of the lower motor neurones situated in the pons, medulla oblongata or spinal medulla (cord), with changes of varying degree in the upper motor neurones (corticospinal and corticonuclear tracts). There is an atrophic paralysis, the degree of spasticity present depending upon the extent of the lesion in the upper motor neurones. This is most marked in amyotrophic lateral sclerosis and in primary lateral sclerosis.

Progressive Ophthalmoplegia

Definition. A disease characterised by paralysis of the external oculo-motor muscles, due to degeneration of the nuclei of their lower motor neurones.

Etiology. The disease is often associated with syphilis. It may occur in tabes dorsalis, or in general paralysis of the insane, or as a manifestation of progressive muscular atrophy.

Pathology. Degeneration occurs in the nuclei of the III, IV and VI cranial nerves.

Clinical Findings. The disease usually has an insidious onset, the patient complaining of diplopia.

On Examination: There is often bilateral ptosis, and weakness or paralysis of various external ocular muscles is found. Later other bulbar nuclei are usually affected, death occurring as in progressive bulbar paralysis.

Progressive Bulbar Paralysis

(Labio-glossopharyngeal Paralysis)

Definition. A disease characterised by wasting of the muscles of the tongue, lips, palate and pharynx, due to degeneration of the cells of origin of the lower motor neurones which supply them.

Complications include inhalation bronchopneumonia, or cardiac and respiratory failure.

Prognosis. Death usually occurs within two years from the onset.

Treatment. No cure is known. Care should be taken in feeding, semi-solids are most suitable, but in some cases resort must be made to nasal feeding.

Progressive Muscular Atrophy

(Progressive Spinal Muscular Atrophy)

Definition. A disease characterised by wasting of spinal muscles, due to degeneration of the cells of origin of their lower motor neurones.

Etiology. The cause is not known. In some cases there is evidence of syphilis, as shown by a positive blood Wassermann reaction. **Predisposing causes:** 1. Age: Usually between 25 and 40 years, but it may begin considerably earlier, as at 12 years, or later, as at over 70 years. 2. Sex: Males predominate.

Pathology. In the majority of cases the lesion is situated in the cervical region of the spinal medulla (cord), but any level may be affected. The spinal medulla (cord) lesion is a degeneration of the anterior horn cells, with or without degeneration of the extramedullary ventral nerve roots. In addition, there is always some evidence pathologically of degeneration of the corticospinal tracts, and of the afferent posterior and anterior spinocerebellar tracts. The muscles affected show wasting of the fibres, healthy fibres often lying side by side with those which have degenerated.

Clinical Findings. In the typical cervical type the patient notices the gradual onset of weakness and wasting of muscles, first in one hand, usually the right, and later in the other. There may be aching or numbness in the hand.

On Examination: There is wasting of the small muscles of the hand, those of the thenar and hypothenar eminences, the interossei and the lumbricals. The hand assumes a claw-shaped deformity, with hyper-extension at the metacarpo-phalangeal joints and flexion at the inter-phalangeal joints. The thumb may rotate outwards to lie in the plane of the fingers. Wasting spreads to the flexors of the forearms and then to the scapulo-humeral muscles, such as the deltoid and serratus anterior. Certain muscles are typically spared, such as the lower part of the pectoralis major, the triceps, the latissimus dorsi and the upper part of the trapezius. The neck muscles and intercostal muscles may be paralysed later. Fasciculation is seen early in muscles which are doomed to atrophy. The deep reflexes connected with the affected muscles are abolished. The electrical reactions show a progressive lack of response both to faradisation and to galvanism, as the fibres degenerate, but often there is no true reaction of degeneration. No sensory changes can be elicited. Exaggerated knee-jerks are an indication of a partial involvement of the corticospinal tracts.

Other types of progressive muscular atrophy occur. Thus in the shoulder type, the scapulo-humeral muscles are first affected, and changes develop later in the hands. In the neck type there is weakness

first of the muscles which support the head, so that it drops forward. In the peroneal type there is weakness of the anterior tibial and peroneal muscles.

Differential Diagnosis. Other causes of wasting of the small muscles of the hand require consideration, such as peripheral neuritis, a cervical rib, cervical pachymeningitis, cervical caries, syringomyelia and rheumatoid arthritis of the wrist. The absence of sensory changes and the presence of fasciculation in progressive muscular atrophy are of great diagnostic value. The shoulder type is differentiated from the facio-scapulo-humeral myopathy by the muscle groups affected, and by the absence of fasciculation in the myopathy. The peroneal type is distinguished from peroneal muscular atrophy (Charcot-Marie-Tooth) by the fact that the latter occurs in children and there is often a familial incidence, and there may be some sensory changes. It is also diagnosed from the distal type of myopathy by the fasciculation.

Course and Complications. If the onset is acute, then the course is likely to be rapidly progressive. In an average case the disease persists for 5 to 15 years. Complications include the development of signs of amyotrophic lateral sclerosis or of chronic bulbar paralysis.

Prognosis. Death occurs in a variable time, as described above.

Treatment. There is no cure known.

Amyotrophic Lateral Sclerosis

Definition. A chronic disease of the brain and spinal medulla (cord), with degeneration of the upper and lower motor neurones.

Etiology. The cause is unknown. *Predisposing causes:* 1. Age: Usually over 40 years. 2. Sex: Males predominate slightly.

Pathology. The upper motor neurone tracts in the spinal medulla (cord) degenerate, the lesion appearing to extend upwards so that the motor cortical cells are affected. The anterior horn cells in the spinal medulla (cord) degenerate, and certain cranial nerve nuclei may be similarly affected.

sphincter control is normal. A jaw-jerk is often present, due to degeneration of the upper motor neurone fibres connecting with the motor nuclei controlling the jaw muscles (V motor). Affection of the cranial nerve nuclei may be shown by disturbance of speech (dysarthria), wasting of the facial muscles (orbicularis oris), difficulty in mastication and swallowing, tremors and wasting of the tongue.

Differential Diagnosis. If in the early stages the hands or arms alone are involved the case closely simulates one of progressive muscular atrophy, to which the disease is allied, and from which its separation is somewhat artificial. Other causes of wasting of the small hand muscles must then be considered (see p. 423). When the legs are primarily affected, the disease resembles primary lateral sclerosis with which it is also closely connected, from the pathological standpoint, and in which the lower motor neurones are not involved. If the cranial motor nuclei are first involved, the case presents the aspect of bulbar paralysis. In a fully developed case there is little difficulty in establishing the diagnosis.

Course and Complications. The course may be rapid or comparatively slow. Involvement of the cranial motor nuclei is a serious sign. Death often occurs from inhalation bronchopneumonia, due to interference with deglutition.

Prognosis. The disease is usually fatal within 4 years from its onset.

Treatment. This is usually only palliative. Mephenesin (Myanesin) Elixir, $\frac{1}{2}$ fl. oz. (15 ml.) t.i.d., may be given for spasticity, hot baths, massage and passive movements also tend to alleviate the spasticity.

THE SPINAL MEDULLA (CORD)

Hæmorrhaxis

(Meningeal Hæmorrhage)

Definition. Hæmorrhage into the meninges of the spinal medulla (cord).

Etiology. The hæmorrhage may be extradural or intradural. Extradural hæmorrhage results from trauma or from rupture of an aortic aneurysm. Intradural hæmorrhage (spinal subarachnoid hæmorrhage) may be due also to trauma or to rupture of a basilar or vertebral aneurysm. In some cases it is due to convulsions, asphyxia, purpura, hæmophilia, or to hæmorrhagic small-pox. It is a condition which is seldom encountered. It is characterised by sudden onset and severe root pains and is often rapidly fatal.

Hæmatomyelia

Definition. Hæmorrhage into the spinal medulla (cord).

Etiology. This is often due to an angioma or other vascular tumour of the spinal medulla (cord), less often to hæmophilia or to a syphilitic arteritis. Small hæmorrhages may be associated with purpura, poliomyelitis, syringomyelia, asphyxia, tetanus and convulsions. Trauma

of the cervical spinal medulla (cord) is not a common cause of hæmatomyelia. *Predisposing causes*: 1. Age: Usually between 15 and 30 years. 2. Sex: The lesion is more common in men.

Pathology. The hæmorrhage often occurs in the cervical region of the spinal medulla (cord); the blood tends to collect in the grey matter, especially the posterior grey commissure, and in the anterior horn cells. There is œdema around the hæmorrhagic area. The hæmorrhage may extend up and down the spinal medulla (cord) for a few segments in a spindle-shaped area. It is absorbed, if the patient survives, leaving either a cyst or a scar. The hæmorrhage thus interferes especially with the sensory tracts conveying pain and temperature sensations, with the anterior horn cells, causing paralysis of the atrophic type of the muscles supplied by the affected segments, and to a lesser degree with the tracts in the white matter, such as the corticospinal and spinothalamic. The posterior columns are usually spared.

Clinical Findings. There may be preliminary pains or numbness and tingling in the neck or shoulders. The onset is usually sudden.

On Examination (the cervical type): The patient is conscious. There is paralysis of the arms and legs, of a flaccid type at the onset, with loss of deep reflexes, constipation and retention of urine. In some cases the paralysis is very slight, but there is dissociated anæsthesia with loss of temperature and pain sensations in the hands and arms. A band of hyperæsthesia may be detected at times at the site of the level of the lesion. There is no disturbance of joint, muscle, vibration or touch sensations. In a severe case there is paralysis of the abdominal and intercostal muscles and respiration is carried on by the diaphragm. The cervical sympathetic may also be paralysed as in syringomyelia. The temperature is usually normal or subnormal at the onset. The cerebrospinal fluid: This is normal at the onset, but later may be yellow (xanthochromia) from blood pigments.

Differential Diagnosis. Hæmatomyelia must be differentiated from acute transverse myelitis, and from syringomyelia. The onset is more gradual in syringomyelia and also in myelitis, and in the latter the temperature is raised. A spinal bruit may sometimes be heard in cases of intradural spinal angioma.

Course and Complications. If the hæmorrhage spreads, death may occur rapidly from respiratory failure. In other cases, after about a week the lower limbs may show a spastic paraplegia with loss of sphincter control, exaggerated reflexes and an extensor plantar response, while an atrophic paralysis develops in the hands and arms. The Brown-Séquard syndrome may also be found, with loss of pain and temperature sensations on the side of the body opposite to the lesion, and paralysis of the leg and trunk on the same side as the lesion in the spinal medulla (cord). If the bleeding is arrested a gradual improvement occurs, with some residual lesions, resulting in weakness of the hands or legs and dissociated anæsthesia at various parts of the body. Complications include cystitis and bed sores.

Prognosis. This is, on the whole, favourable as regards life unless

the lesion is in the cervical region, but some permanent disability is likely to persist.

Treatment. The patient must be kept absolutely at rest in bed, and he may with advantage lie either prone or on his side. An ice bag should be applied over the spine at the site of the lesion. A subcutaneous injection of morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.) tends to calm the patient and slow the circulation, and is therefore of value.

Myelitis

Definition. Inflammation and degeneration of the spinal medulla (cord).

Etiology. Acute myelitis may be met with under a variety of conditions. Thus it may result from exposure to cold, from trauma without visible external injury as after diving with the neck flexed, or from exposure to the concussion of shells. It may also be a manifestation of acute anterior poliomyelitis, acute or subacute encephalomyelitis or of herpes zoster. In some cases it occurs as a complication of illnesses such as influenza, typhoid fever, dysentery, measles, syphilis or gonorrhœa. Compression myelitis is due to pressure outside the spinal medulla (cord) and is considered separately. Acute suppurative myelitis is a rare complication of bronchiectasis and bacterial endocarditis, of tuberculous or suppurative spinal caries, of purulent meningitis, and of an infected meningocele or dermoid cyst. Chronic myelitis is usually due to syphilis.

Pathology. In acute myelitis the spinal medulla (cord) is swollen at the affected site, which may be located to a transverse area of the spinal medulla (cord), usually in the mid-thoracic region; more rarely there is a diffuse myelitis extending up and down the spinal medulla (cord), or disseminated patches are found. On section, the spinal medulla (cord) is soft, and no distinction can be made between the grey and white matter. On microscopical examination the nerve cells are found to have undergone chromatolysis and the nerve fibres are degenerated. In chronic myelitis the cord is smaller than normal and pale.

Clinical Findings. *Acute Myelitis.* The onset is usually comparatively sudden. There may be a history of any of the antecedent conditions described above. The patient is usually a young adult, and he may notice a preliminary sense of numbness or tingling in the feet or legs, or of pains in the legs or body, or of a sense of girdle constriction round the body at the level of the lesion.

On Examination: Thoracic Transverse Myelitis. The legs are found to be paralysed; at the onset the paralysis is of the flaccid type with loss of the knee- and ankle-jerks. The abdominal reflexes are lost, but the epigastric reflex is preserved if the lesion is below the 9th thoracic segment. Priapism may be present. There is retention of urine and of fæces. Sensation is lost over the legs and lower part of the body, but at the level of the lesion a zone of hyperæsthesia may be found. Later the paralysis becomes spastic, the extensor muscles being affected more than the flexors, the deep reflexes

of the legs are exaggerated and the plantar responses become extensor.

Lower Cervical Transverse Myelitis. This is more rare. The arms and legs are paralysed, and later, while the legs become spastic, the paralysis of the arms is of the flaccid atrophic type. The cervical sympathetic may be involved on one or both sides, with enophthalmos and constriction of the pupil. Sensation is lost below the level of the lesion.

Lumbar Myelitis. There is flaccid paralysis of the legs, with loss of the knee- and ankle-jerks and of the plantar responses. The latter may at times be extensor. The bladder and rectum become incontinent. The temperature is raised in cases due to infection.

The cerebrospinal fluid: In any type this may show an increase of globulin and of cells.

Acute Diffuse Myelitis. There is an ascending paralysis which spreads up the legs to the trunk and arms, together with an ascending anaesthesia. There is loss of sphincter control. Bed sores and cystitis are very liable to develop.

Chronic Myelitis. The paralysis is of gradual onset, with first weakness and stiffness in the legs, and later sensory loss, exaggeration of the deep reflexes and extensor plantar responses.

Differential Diagnosis. In spinal thrombosis or hæmorrhage the onset of the paralysis is generally more rapid than in myelitis, and there is no fever. In acute infective polyneuritis there is a flaccid paralysis, pains in the legs are usually present, there is no loss of sphincter control, and the sensory disturbance is less marked than in myelitis. Landry's paralysis is by some considered to be indistinguishable from acute infective polyneuritis. In hysterical paraplegia other stigmata of hysteria can usually be detected.

Course and Complications. The course in acute myelitis is very variable; in the diffuse variety the lesion may rapidly spread up the cord, and death ensue from paralysis of the muscles of respiration. In transverse myelitis there is a tendency to recovery, which is, however, rarely complete. Some degree of spastic weakness of the legs is liable to persist, with contractures of the flexor muscles, so that the patient has to walk with the aid of two sticks. Impotence is liable to occur as a sequela. Complications include cystitis, pyelitis, pyelonephritis, and bed sores.

apparatus can be used to produce automatic tidal drainage of the bladder. The urine should be kept acid by the administration of acid sod. phosphate 30 to 60 gr. (2 to 4 G.) twice a day. If the Wassermann reaction is positive a course of anti-syphilitic treatment should be given (see p. 600).

Compression Myelitis

Etiology. In the majority of cases the compression of the spinal medulla (cord) is produced gradually. It may be due to affections of the vertebræ, such as tuberculous or syphilitic caries, Paget's disease, vertebral tumours, such as primary or secondary sarcoma and secondary carcinoma, an exostosis, osteoma or chondroma. It may also occur as a complication of rheumatoid spondylitis or be due to protrusion of an intervertebral disc. Tumours of the meninges or nerve roots may compress the spinal medulla (cord), such as an extradural sarcoma or an intradural sarcoma or fibroma. Leukæmia and Hodgkin's disease are comparatively rare causes. Syphilitic pachymeningitis hypertrophica may compress the spinal medulla (cord), usually in the cervical region. A hydatid cyst or a simple meningeal cyst will cause pressure. It is rare for an aortic aneurysm to erode the spine sufficiently deeply to compress the spinal medulla (cord). With a fracture dislocation of the spine the compression is rapidly produced. This is a surgical condition.

Clinical Findings. *Affections of the Vertebræ:* The patient is often a child if the lesion is tuberculous caries, and in other cases he is generally an adult. Pain is complained of in the back, and often very severe root pains are present, radiating in a segmental distribution round the body or along the limbs, due to dorsal nerve root involvement. Slight movement of the spine or coughing may cause very severe agony. Later, weakness with spasticity occurs in the legs, and numbness or tingling.

On Examination: In caries angular curvature of the spine is often seen, and local tenderness on tapping may be found over one or more vertebræ. In the early stages a zone of hyperæsthesia may be present, corresponding with a segmental distribution of the spinal medulla (cord). Later there may be anæsthesia over an area in which severe pain is felt (anæsthesia dolorosa). Motor signs sometimes occur before the sensory ones, and when present resemble those described above for transverse myelitis, there being spastic weakness of the legs, exaggerated deep reflexes and an extensor plantar response. With progressive pressure the extensor muscles are first affected, the legs being spastic and extended, and from time to time involuntary clonic contractions occur (paraplegia in extension). Stimulation of the sole of the foot may cause not only extension of the big toe (dorsi-flexion), but also flexion of the knee and hip. Later the extensors lose their tone and the flexors are contracted (paraplegia in flexion), the hips and knees being flexed and the knee- and ankle-jerks being lost. With malignant tumours of the vertebræ excruciating root pains are a characteristic feature; there is localised vertebral tenderness but little liability to motor weakness, as death usually occurs before there is time for this to develop.

of the superficial and deep reflexes, which correspond with certain spinal levels, as enumerated on p. 303. The superficial reflexes are abolished below the level of the lesion, whereas the deep reflexes are exaggerated. The various muscles also correspond with certain spinal levels, as shown in the table on p. 303, and so paralysis of definite muscles indicates the site of the lesion. Myelography will indicate the level of obstruction in a spinal medulla (cord) compression, due either to intra- or extra-dural causes.

Differential Diagnosis. In diagnosing the cause of spinal compression the spine should first be examined for deformity, and also a radiogram taken. If the disease is due to an affection of the vertebræ it can usually be determined in this way. The presence of a primary malignant growth elsewhere in the body and of severe root pains is very suggestive of a malignant deposit in the vertebræ. In meningeal tumours the diagnostic features are the root pains and subsequent spastic paralysis, at first unilateral and later bilateral, with sensory disturbances. It is not usually possible to differentiate clinically between a meningeal and spinal tumour. When pain is the most prominent symptom a diagnosis of rheumatism or neuritis is liable to be made, unless a careful examination is carried out to exclude tumours or compression myelitis.

Course and Complications. The course depends upon the cause of the compression. Thus in malignant growths of the vertebræ the course is rapidly progressive, whereas a meningeal tumour may exist for several years. In spinal caries the course is very variable and often the disease is arrested.

Prognosis. This must vary with the cause, as described above.

Treatment. Spinal caries is treated by streptomycin, isoniazid, para-aminosalicylic acid, rest and exposure to sunlight. In secondary malignant vertebral tumours nothing can be done to cure, but pain may be relieved by division of the dorsal nerve roots. Many spinal and meningeal tumours can be removed by operation. The Wassermann reaction should always be carried out, and, if positive, a course of anti-syphilitic treatment given before an operation is performed. If there is no improvement, operation should not be delayed for more than 3 to 4 weeks, as a tumour may be present which is not a gumma.

Compression of the Cauda Equina

Etiology. This may be due to a fracture dislocation in the region of the lower lumbar vertebræ, to spinal bifida, chronic arachnoiditis, a fibrous band, a prolapsed intervertebral disc, or to a tumour. Extra-dural tumours include a sarcoma and chondroma, and intradural tumours a meningeal or perineural fibroblastoma. The cauda equina embraces the nerve roots below those arising from the second lumbar segment of the spinal medulla (cord).

Clinical Findings. The patient complains of pain in the lower part of the back or the legs, having a root distribution. There is also weakness of one or both legs, and often retention or incontinence of urine and fæces.

On Examination: The leg or legs show muscular weakness or paralysis, with loss of tone and wasting. The knee-jerk and ankle-jerk are absent. The plantar response is absent or flexor. Loss of sensation is found in the legs and perineum.

Prognosis. This varies with the cause; when due to trauma recovery often occurs.

Treatment. If a tumour is suspected an exploratory laminectomy should be performed. Otherwise the treatment is as for compression myelitis.

Acute Poliomyelitis and Polioencephalitis (Heine-Medin Disease. Infantile Paralysis)

Definition. An acute disease characterised by lesions having a special affinity for the grey matter of the anterior horns of the spinal medulla (cord) and for the motor nuclei of the brain stem.

Etiology. The disease is caused by a virus of which there are 3 types, Brunhilde, Lansing and Leon. Infection takes place either by droplets disseminated by carriers or abortive cases, or by milk, food or water contaminated by faeces or flies. There is evidence to show that a human being may be infected by the bite of a budgerigar excreting Type-1 poliomyelitis virus. Epidemic and sporadic infection occurs. It is now recognised that spread of infection in the family or in hospital is very liable to occur. *Predisposing causes:* 1. Age: Chiefly between 2 and 5 years, adolescents and young adults are sometimes affected. Since 1947 the majority of cases in Great Britain have developed between the ages of 6 to 12 years. 2. Sex: Males predominate slightly. 3. Season: Summer and autumn, but in all districts sporadic cases are constantly present. 4. Locality: America, Canada, Australia, Scandinavia and to a lesser degree Great Britain. 5. Tonsillectomy: This predisposes to infection, and the bulbar type is then liable to occur. 6. There appears to be a relationship between immunisation against pertussis and diphtheria, and the development of poliomyelitis within the next 60 days. Further, the severe paralysis is likely to be localised to the limb last inoculated. Such cases have been observed in Australia and Great Britain.

Pathology. The virus is present in the naso-pharyngeal mucous membrane in carriers, convalescents and in acute cases. It is also found in the faeces. It is believed that in the majority of cases infection in man is through the alimentary tract, the virus spreading to the central nervous system along autonomic nerves. Less often infection is through the naso-pharynx, especially after tonsillectomy. The virus may be present in the faeces during convalescence for over 3 months and it may also be detected in sewage. Flies fed on infected human faeces can convey the virus to food.

Destructive lesions are present in the grey matter of the spinal medulla (cord) and brain. The grey matter of the anterior horns of the cervical and lumbar enlargements is especially affected. The changes in some of the anterior horn cells appear to be reversible, as shown by clinical recovery at times of certain paralysed muscles. There is inflammation of the leptomeninges, particularly over the anterior median fissure of the spinal medulla (cord). The grey matter of the spinal medulla (cord) on section may appear swollen and pink. Microscopically there is a round-celled infiltration around the anterior spinal vessels, many of the cells being polymorphonuclears, producing a "cuffing" effect. There is degeneration of cells in the anterior horns. The cerebral and cerebellar cortex, the basal ganglia and brain stem may also be affected. Sensory changes are probably due to involvement of spinal ganglia. There may also be a generalised enlargement of lymph nodes with parenchymatous changes in the liver and kidneys.

Incubation Period. This is from 4 to 80 days or longer.

Clinical Findings. *Subclinical infection* may occur, the individual being infected with the virus and developing immunity, without there being any symptoms of ill health. The *minor illness* is more common in children than in adults. It is characterised by fever, headache, vomiting or sore throat. After lasting for a day or so it may abort, constituting the whole illness. In other cases it is followed after an interval of about 2 days by the *major illness*, or the major illness may appear without a preliminary minor illness. The major illness may be paralytic or non-paralytic.

Non-paralytic cases fortunately constitute the majority of cases in many epidemics, the infection stopping before the anterior horn cells or motor nuclei are involved. The symptoms in these cases belong to the *prodromal or pre-paralytic stage*. They are as follows: The patient is taken ill comparatively suddenly with headache, malaise, pains in the neck, back and limbs, nausea, vomiting, diarrhoea and perhaps convulsions. The temperature is raised to about 103° F. (39.4° C.). In some instances there is diplopia. This prodromal stage may be very short, or it may last for a day or so. Signs of meningeal irritation may or may not then develop. There is very intense headache.

On Examination: Definite neck rigidity may be found. If Kernig's sign is not present, the spinal sign may be elicited. The patient lies on his side, if now an attempt is made by the examiner to flex the spine, the movement is resisted by the patient owing to pain in the back. The skin often has a pink hue and there is an anxious look in the eyes. Small and uncontrolled movements may be seen in the fingers and hands. The cerebrospinal fluid: The fluid is clear and under increased pressure. There is an excess of cells present (15 to 200 per c.mm.), both polymorphonuclears and lymphocytes. The protein is increased, the sugar and chlorides are normal, and no organisms are found. The blood: There is often a leucocytosis of about 25,000 per c.mm.

The Paralytic Stage. Muscular paralysis is noted about the second or third day. It is usually maximal at the onset, but in some cases spreads rapidly. Various types of disease are described, of which the commonest

paralysis has appeared and the muscles are tender and painful, the disease may be mistaken in infants for scurvy, acute rheumatism, osteomyelitis or syphilitic epiphysitis. The neuritic form is differentiated from multiple neuritis by the fever and by special groups of muscles being affected. The spreading type closely resembles Landry's paralysis. Epidemics of a disease resembling poliomyelitis, and affecting hospital nursing staffs, have been described at the Royal Free Hospital, London, in 1957, at the Addington Hospital, Dublin, in 1959, and at the Alexandra Hospital, Athens, in 1959. The disease has been called epidemic myalgic encephalomyelopathy. The cause is unknown.

Course and Complications. Although in the majority of cases the paralysis is maximal at the outset, the paralysis may spread in a few hours from muscle group to muscle group. Usually many of the anterior horn cells, which are put out of action at the onset, recover, with corresponding improvement in muscle power noticeable after about 7 to 10 days. Relapses are not unknown during the course of the illness, with rise of temperature and further paralysis of muscles, but they are not usually serious. Some of the affected muscles recover completely, others undergo partial recuperation, and others may be permanently paralysed. Scoliosis or kyphosis may result from a minor attack of poliomyelitis which has picked out certain spinal muscles. The bones of the affected limbs do not usually grow as well as normal, with subsequent shortening of the leg or arm. Contractions and deformities result from permanently damaged muscles. Progressive muscular atrophy has occasionally been noted as a late sequela.

Prognosis. The mortality rate in an epidemic varies between about 10 and 20%. In the bulbar type the mortality rate varies from 40% to 80%. Complete recovery may be expected even if all four limbs are paralysed, if the superficial and deep reflexes persist. Muscles which are painful and tender are more likely to recover than those which are insensitive. The mortality is very high when the medulla oblongata is affected, and spreading infection is usually very serious, death resulting from bulbar or spinal respiratory paralysis or from bronchopneumonia. A muscle which responds to faradisation usually recovers, but the prognosis is serious if the reaction of degeneration is present. Some degree of recovery may be expected for a year after the onset of the disease.

Treatment. *Prophylactic.* The Salk trivalent formalised vaccine has been largely replaced by the Sabin attenuated trivalent live vaccine which is given by mouth, 3 drops on a lump of sugar. This is given in infancy, 3 doses at intervals of 4 weeks. It is repeated a year later, and again at the age of 5 and 10 years. It should not be given if the patient has diarrhoea. Unvaccinated contacts may be given an intramuscular injection of concentrated immune globulin (gamma-globulin) 0.2 ml./kg. body weight, or of 10 ml. of convalescent serum obtained from a patient within 10 days of his becoming afebrile. Food, milk and water should be protected from flies, and flies destroyed by D.D.T. If an outbreak occurs in a boarding school there are arguments for and against

sending the pupils home. The risk of so doing consists in planting a carrier in a new zone, where he will spread the infection. The child must be kept in quarantine for 21 days. On the other hand, if healthy children are kept in the school they run the risk of contracting the disease from a carrier or from infected food or water.

Curative. The patient should be isolated for three weeks after the temperature has become normal or for 6 weeks from the clinical onset of the disease. As the virus is eliminated in the faeces and probably in the urine, strict precautions should be taken with regard to their disinfection and disposal. The patient should be kept in bed even in the mildest case, as this is likely to prevent the onset of the paralytic stage. The general consensus of opinion is opposed to the use of convalescent or adult serum. Lumbar puncture during the meningitic stage usually relieves temperature, headache and muscular pains, and may be repeated for the first 2 or 3 days. Great care must be taken to prevent stretching of paralysed muscles and a footboard should be used to maintain dorsiflexion of the feet, and to take the weight of the bed-clothes. The limbs must be placed in such a position that the affected muscles are relaxed and the position maintained by pillows, sandbags, or celluloid splints. Gentle passive movements may be used with benefit in the early stages. The tightness or spasm of the spinal or hamstring muscles may be relieved by hot packs applied for 1 to 2 hours morning and afternoon, as advised by Elizabeth Kenny. Patients who sweat profusely should be given plenty of fluid by mouth and sodium chlorid. $7\frac{1}{2}$ to 15 gr. (0.3 to 1 G.) t.d.s. When the respiratory muscles are affected, artificial respiration may be carried out for prolonged periods automatically by the use of a respirator. In cases of bulbar palsy the chief danger is inhalation of food. Artificial respiration can be carried out through a cuffed tracheostomy tube by intermittent positive pressure respiration, using a respiration pump to blow air into the lungs. Pain may be relieved by the administration of aspirin in doses of 5 to 10 gr. (0.3 to 0.6 G.) t.d.s., according to the age of the patient. Tolazoline hydrochlor (Priscol) may be given for relief of pain and to increase the vascularity of the affected muscles. The dose for an adult is two 25 mg. tablets four times a day. The muscles should not be massaged during the period of active infection, and no electrical treatment should be given. After 3 or 4 weeks, gentle massage may be applied. Orthopædic treatment may improve contractures of deformities, but will not be required for at least a year after the onset of the illness.

polioencephalomyelitis. Probably both types exist. One case of acute ascending myelitis has been shown to be due to a neurotropic filtrable virus. *Predisposing causes* : 1. Age : 20 to 45 years. 2. Sex : Males predominate.

Pathology. In some cases no changes are found post-mortem ; in others there is hyperæmia of the vessels of the spinal medulla (cord), chromatolysis of the anterior horn cells, or interstitial changes in the peripheral nerves.

Clinical Findings. The patient is usually suddenly seized with weakness, first in one leg and then in the other. There may be prodromal symptoms, such as malaise, numbness or tingling in the feet, or pains in the back or legs. The paralysis rapidly spreads up the legs. In the case originally described by Landry the shoulders, the arms and hands were next paralysed, and finally paræsthesia spread to the trunk and there was dysphagia. This corresponds with a neuritic origin of the disease. In other cases, subsequently classified as Landry's paralysis, the trunk is affected after the legs, then the arms, neck, head and finally the tongue and muscles of deglutition. Involvement of the diaphragm and intercostal muscles usually results in death from respiratory failure.

On Examination : Spinal motor system : There is flaccid paralysis of the legs, trunk and arms, and finally of the neck, face and head. The diaphragm and intercostal muscles may or may not be affected. The muscles do not waste, or only very slightly. Spinal sensory system : Often there are no changes ; some loss of touch sensation may be detected in the toes. The reflexes : The deep and superficial reflexes are lost. The sphincters are usually unaffected, but there is often retention of urine and of fæces from lack of muscular power. In some cases the XII, XI, VII, or III, IV and VI nerves may be affected. Trophic changes : These do not usually occur. Electrical reactions : There is no reaction of degeneration. Response to galvanism is usually lost, but faradic response remains. Lumbar puncture : The fluid is usually under increased tension. It is clear, and may contain an excess of gamma-globulin. Cerebration : The mind usually remains clear until the end. The temperature is not usually raised. The spleen may be palpable.

Differential Diagnosis. Acute toxic polyneuritis : By some authorities this is held to be indistinguishable from Landry's paralysis. However, in the former there is more likely to be fever, pain in the limbs, with anæsthesia, and wasting of muscles. The abdominal reflexes may also be present. Acute ascending myelitis : Here there are more marked sensory changes, with sphincter paralysis and the development of bed sores. The plantar responses are likely to be extensor. Acute polioencephalomyelitis : The spread of the paralysis is more irregular, there is fever and wasting of the paralysed muscles. An acute ascending paralysis may occur in rabies and in porphyria.

Course and Complications. The disease is usually rapidly progressive. Deglutition bronchopneumonia may occur as a complication.

Prognosis. Death frequently occurs in a few hours or days. This

may be due to paralysis of the respiratory muscles or of the heart, or to deglutition bronchopneumonia. If the patient recovers, there is usually no wasting or paresis of the affected muscles.

Treatment. When the respiratory muscles are affected the patient should be put in a respirator. Nasal feeding, inhalations of oxygen, and tracheostomy may also be required. Lumbar puncture should be made as required to relieve the increased tension of the spinal fluid.

Multiple Sclerosis

(Disseminated Sclerosis)

Definition. A disease characterised by spastic weakness of muscles, with a progressive course often interrupted in the early stages by remissions.

Etiology. The cause is not known. It has been thought to be due to the action of toxins or to the presence of a myelinolytic ferment in the blood. It may be an autoimmune disease. Various possible causative organisms have been described, such as a virus, without sufficient evidence to justify their acceptance. Other causes suggested include scattered venous thrombosis with increased coagulability of the blood, localised areas of vasoconstriction, and allergic reactions. *Predisposing causes:* 1. Age: Usually between 20 and 40, rarely under 18 or over 45. 2. Sex: Females predominate slightly. There is no familial incidence but several cases may occur in a household. The disease may show itself after an attack of influenza, scarlet fever or exposure to cold. It is a very commonly occurring nervous disease. In severe cases there is an increase of blood group A over the normal average.

Pathology. Lesions are scattered throughout the brain and spinal medulla (cord), varying in size from a pin point or less to about $\frac{3}{4}$ inch (10 mm.) in diameter. The recent lesions are pinkish in colour and the old ones greyish-white. They are present both in the grey and white matter of the central nervous system, and the optic nerve is often affected. There is degeneration of the myelin sheath of the nerve fibres, the axis cylinder usually remaining intact. There is also a perivascular infiltration with lymphocytes and plasma cells and some local œdema. In the older lesions there is proliferation of neuroglial tissue. Secondary degeneration above or below the damaged area in the spinal medulla (cord) rarely occurs.

plegia during which the patient does not lose consciousness, or with epileptiform convulsions. It is unusual for the weakness to affect the arms before the legs.

On Examination: In the early stages no abnormal signs may be found, and in such a case the patient should be re-examined from time to time so that a diagnosis can be established as soon as possible. A tendency to laugh easily, unnatural cheerfulness or euphoria may be noted in the early and advanced stages of the disease. The signs which occur in multiple sclerosis are as follows: Weakness may be detected in certain groups of muscles, such as the flexors of the ankles or of the hip. There is a tendency to spasticity of the leg muscles. The knee-jerks and ankle-jerks are brisk, and ankle clonus and patella clonus may be present. The plantar response is extensor. The abdominal and cremasteric reflexes are lost. Areas of loss of cutaneous sensation may be found on the legs; the bone vibration sense is diminished or lost in the legs; joint sensation is usually lost. Pallor may be detected in the temporal halves of the optic discs. In cases of loss of vision in one eye there is a retrobulbar neuritis. The affected pupil is usually dilated, and does not respond well to direct stimulation by light, although it contracts consensually when a light is shone into the other eye. A small central scotoma for colours may also be present. Weakness of accommodation may be a troublesome feature. A history of transitory diplopia or urinary disturbance may be obtained on questioning. In more advanced cases the triad of symptoms described by Charcot may be found. These are nystagmus, intention tremors and scanning speech. The nystagmus is a fine horizontal one. "Jelly nystagmus" is almost a diagnostic sign when present. On ophthalmoscopic examination the fundus appears to quiver rapidly. The intention tremors are seen when the patient is asked to lift up a glass of water or perform some other movement, and become more marked towards the completion of the act. The speech is slow and the syllables are pronounced somewhat abruptly. There may be difficulty in beginning micturition, or incontinence. In the later stages contractures occur in the spastic muscles, and there are marked tremors of the head, neck and arms, so that the patient is bed-ridden and unable to look after herself. Other types include a cerebellar variety characterised by vertigo, ataxia and nystagmus, and a cerebral one, with progressive hemiplegia. The blood: The Wassermann reaction is negative. The cerebrospinal fluid: This may be normal. In about 30 to 70% of cases a paretic gold curve is obtained (see Fig. 26). There may also be an excess of cells and globulin.

Differential Diagnosis. In the early stages the disease is very liable to be mistaken for hysteria, or the retrobulbar neuritis may be thought to be due to sphenoidal sinusitis. When there is spastic paraplegia, spinal syphilis must be excluded, and local pressure due to bony changes or a spinal medulla (cord) tumour. The ataxy must be distinguished from that due to Friedreich's ataxia, in which the deep reflexes are depressed and ataxic paraplegia raises the consideration of subacute degeneration of the spinal medulla (cord).

Course and Complications. In the early stages remissions are a very characteristic feature, the weakness of the limb disappearing and reappearing later. Fresh symptoms appear at different parts of the body as new lesions develop in the central nervous system. Arrest may occur at any stage, or the patient may rapidly become bed-ridden. Complications include septic infection of the urinary tract and inter-current lung infections.

Prognosis. This is unfavourable, death sometimes occurring in a few months, but in other cases not for 30 years or more after the onset. About 80% of patients may be at work 10 years from the onset.

Treatment. There is no known cure. Any obvious septic focus should be eradicated. For the painful nocturnal flexor spasm of the legs chlordiazepoxide (*Librium*) 10 mg. caps. t.i.d. sometimes give relief. Corticotrophin, 20 i.u./ml., may be used in acute exacerbations of the disease in doses of 80 units of the gel, intramuscularly daily for 7 days, then 40 units daily for 7 days, and 20 units daily for the third week. Potassium chloride, 0.5 G. tab., should be given b.i.d. during the treatment. In some cases a maintenance dose of 20 units of corticotrophin gel three times a week has met with varying success.

General measures include the avoidance of fatigue and the use of hot baths to diminish spasticity.

Neuromyelitis Optica

(*Devic's Disease*)

This is another demyelinating disease characterised by disseminated myelitis, retrobulbar neuritis and at times papilloedema. Clinically there is blindness with paraplegia, sensory loss and incontinence. In some cases there is almost complete recovery, but the death rate is about 50%.

Syringomyelia

(*Syringoencephalomyelia*)

Definition. A disease characterised by a peculiar sensory disturbance, muscular wasting and trophic lesions, due to cavity formation and neuroglial overgrowth in the spinal medulla (cord) and mid-brain.

is generally situated posterior to the central canal in the posterior grey commissure. It is most likely to be present in the lower cervical and upper thoracic regions, running up and down the spinal medulla (cord) for a variable distance. Thus it may extend for a few segments, or run the length of the spinal medulla (cord) and into the medulla oblongata. The cavity may branch and vary in size from a small hole to one occupying the greater part of the transverse section of the spinal medulla (cord). The spinal medulla (cord) may be distended and cause pressure on the vertebrae. The cavity may contain a thin watery or glairy fluid, and may communicate with the central canal of the spinal medulla (cord) and be lined with ependymal cells. The neuroglial overgrowth occurs around the cavity, and isolated masses of neuroglial tissue may be present at varying sites in the spinal medulla (cord). The cavity and the surrounding neuroglial overgrowth are most likely to interfere with the nerve fibres entering from the dorsal root on one or both sides which convey impulses of pain and temperature, and cross the cord in the anterior white commissure to ascend in the spinothalamic tract on the other side. If the cavity extends further outwards it may involve the fibres entering from the dorsal root which convey impulses of touch and ascend on the same side of the spinal medulla (cord). Extension forwards into the grey matter causes atrophy of the anterior horn cells, and lateral extension may interfere with the pyramidal tract.

Clinical Findings. The onset is usually insidious. The patient may first notice pains in the hand or arm, or weakness of the hands, or clumsiness in fine movements. In other cases he burns his fingers with a cigarette without feeling heat or pain, or a cut on the finger is painless. If there is gross dilatation of the cervical spinal medulla (cord), severe pain may be felt in the neck.

On Examination: In an established case of the cervical type the following changes may be found. There is usually kyphoscoliosis in the thoracic region, and a spina bifida may be present. Spinal motor system: There is wasting of the small muscles of one or both hands, so that a claw hand or monkey hand is seen. The muscle wasting may extend to the arm and shoulder girdle, with winging of the scapula. In muscles which are actively wasting, fasciculation may be seen. The deep reflexes of the arms may be increased or diminished, and a reaction of degeneration may be present in the affected muscles. There is often spastic weakness of the legs, with increased knee-jerks and ankle-jerks and an extensor plantar response. Spinal sensory system: Sharply defined areas of dissociated anaesthesia are present on the hands, arms, neck, trunk, etc. There is loss of sensation to heat, cold and pain, whereas touch sensation, the discrimination of two points, joint sensation, muscle sensation, and the vibration sensation are preserved. In some cases there is a complete hemi-anaesthesia to pain and temperature senses on the opposite side of the body below the level of the lesion, due to involvement of the spinothalamic tract. Trophic changes include painless swelling of the shoulder, elbow or wrist, similar to the Charcot's arthropathy of tabes dorsalis. The bones of the arm may break spontaneously. The hands may be enlarged and thick, *main succulente*,

owing to thickening of the subcutaneous tissues; painless ulcers or subcutaneous whitlows may occur on the fingers, patches of red or blue skin may be seen on the hands. Involvement of the cervical sympathetic on one side is indicated by Horner's syndrome, *i.e.*, enophthalmos, narrowing of the palpebral fissure, contraction of the pupil and absence of sweating on one half of the face. Other types of the disease are more rarely met with. They include: *The thoracico-lumbar variety*: There is wasting of the muscles of the pelvic girdle and legs, and dissociated anæsthesia of the legs. *The sacro-lumbar variety*: The small muscles of the feet and the leg muscles waste. Trophic lesions may be seen on the feet. There is dissociated anæsthesia of the feet or legs. There is usually loss of control of the bladder and rectum. The deep reflexes are often exaggerated in the legs and the plantar response is extensor. *The bulbar type (syringobulbia)*: Bulbar symptoms may occur in the cervical type, or independently. The lesions are usually unilateral, such as laryngeal paralysis, dysphagia, wasting of half of the tongue, nystagmus and ocular paresis, anæsthesia of half of the face, or facial weakness. Further, certain clinical types are described, such as: 1. The classical type depicted above under the cervical variety. 2. The motor type, in which motor symptoms predominate and resemble those of amyotrophic lateral sclerosis. 3. The sensory type, which may be mistaken for hysteria. 4. The trophic type, here all sensation may be lost in the hands and painless whitlows and ulcers occur (Morvan's disease). 5. The tabetic type, in which the lesion spreads into the posterior columns, and there are loss of knee-jerks, Rombergism, severe pains and arthropathies of the legs.

Differential Diagnosis. The diagnosis of syringomyelia is established by the presence of dissociated anæsthesia. Difficulty occurs in cases in which motor symptoms predominate or are first noted. Then other conditions, such as a cervical rib, progressive muscular atrophy, amyotrophic lateral sclerosis, multiple sclerosis and lateral sclerosis, may require exclusion. Horner's syndrome may also result from thrombosis of the posterior inferior cerebellar artery, a cervical rib, a spinal medulla (cord) tumour, multiple sclerosis, or a hæmorrhage at the level of C. 7 to Th. 1, cervical pachymeningitis, an aortic aneurysm, mediastinal or cervical tumour, apical lung carcinoma, apicolysis, thoracoplasty, trauma, stellate ganglionectomy, or occur in partial facial hemiatrophy (the Parry-Romberg syndrome). In hamatomyelia the signs may closely resemble those of syringomyelia, but in the former the onset is more sudden, and, as the blood is absorbed, the signs gradually disappear.

Treatment. No cure is known. Care should be taken to protect anæsthetic areas from injury. Deep X-ray treatment to the affected area of the medulla oblongata or spinal medulla (cord) may relieve pain, improve the trophic changes and increase muscular power, but in many cases it is not successful. Pains may also be relieved by tab. codein. co. 1 t.i.d. Operations to drain the cavity or relieve pressure on the vertebræ are often fatal.

Subacute Combined Degeneration of the Spinal Medulla (Cord) (*Subacute Combined Sclerosis*)

Definition. A disease characterised by degeneration of the posterior and lateral columns of the spinal medulla (cord), with anæmia of the pernicious type and achylia gastrica.

Etiology. The disease is usually associated with pernicious anæmia, less often with other types of anæmia. In some cases the anæmia is slight whereas the nervous changes are severe. It may occur after partial gastrectomy, and is probably due to vitamin B₁₂ deficiency, resulting from malabsorption. *Predisposing causes:* 1 Age: 30 to 65 years. 2. Sex: The incidence is equal. In some cases there is a familial occurrence of the disease.

Pathology. The lower thoracic part of the spinal medulla (cord) is usually the first site of the lesion. There is degeneration of the white matter, which begins in the posterior or lateral columns in irregular patches. These tend to fuse and to spread up and down the spinal medulla (cord) in a funicular manner, and the internal capsule of the brain may be affected. The medullary nerve sheaths and later the axons in the spinal medulla (cord) degenerate. There is very little tendency to a proliferation of neuroglial tissue. The peripheral nerves may show degeneration, but the grey matter of the spinal medulla (cord) and the nerve roots themselves are not usually affected. Changes characteristic of pernicious anæmia may be found in other parts of the body.

Clinical Findings. The patient is usually an adult of middle age, who complains of the gradual onset of peculiar feelings in the legs or arms, such as numbness, pins and needles, burning or pains. These sensations are frequently first felt in the toes or fingers, and later extend up the limbs. Sharp "lightning" pains may also be felt in the limbs, or a "girdle" sensation around the trunk. The legs gradually feel heavy and walking is an effort. When the eyes are closed, or when the patient is in the dark, he may feel definitely unsteady. Impotence is the first symptom in some cases. Often the blood shows evidence of pernicious anæmia when the nervous symptoms appear, although it is rare for subacute combined degeneration to develop in a patient who has been adequately treated for pernicious anæmia. Many cases have, however, been recorded in which no definite anæmia was detectable when the nervous symptoms appeared. An acute onset is more rare, with fever, vomiting and diarrhœa, and pains in the back and legs.

On Examination: Spinal sensory system: Changes are usually

first detected here. Anæsthesia for pain, temperature and touch may be found in the periphery of the legs or arms in a stocking or glove area. Vibration sense disappears in the tibiæ. The joint sense of the big toe is lost. The calf muscles may be unduly tender on pressure. On the trunk, segmental areas of anæsthesia may be detected. Spinal motor system : The muscles of the legs become weak and their tone increased, but in some cases there is a flaccid paresis. There may be wasting of the small muscles of the hands. The reflexes : The knee-jerks and ankle-jerks are usually exaggerated and an extensor plantar response is obtained. In the flaccid type of paresis the knee-jerks and ankle-jerks are sluggish, but the plantar response here is usually extensor. The abdominal reflexes are generally exaggerated. The sphincters become paralysed late in the disease. Co-ordination: Loss of postural sense gives rise to inco-ordination and Rombergism. The gait : This is ataxic. Trophic changes : Œdema of the subcutaneous tissues and bed sores are liable to develop in advanced cases. The cranial nerves : In some instances there is primary optic atrophy or optic neuritis. Nystagmus may also be present. Involvement of the cervical sympathetic will give rise to enophthalmos and constriction of the pupil, usually on one side. Mentality : There may be a gradual lowering of the mental calibre of the patient. The cerebrospinal fluid : This is normal. Electrical reactions : There is usually no reaction of degeneration, but a gradual diminution of response to electrical stimuli occurs. *General examination :* The tongue is often smooth and shiny. The blood : Changes typical of pernicious anæmia are generally found in cases of some duration. The fractional test meal shows achylia gastrica, as in pernicious anæmia. The vitamin B₁₂ content of the serum is below normal. The spleen may be palpable. During the course of the disease an irregular degree of fever may be noted.

with marked evidence of anæsthesia, and finally there is a flaccid paraplegia with loss of sphincter control. It is comparatively rare for the disease to pursue a rapid course of a few weeks or months. Complications include cystitis, pyelitis, pyelonephritis and bed sores.

Prognosis. Before the introduction of liver treatment death occurred in 2 to 3 years from the onset of symptoms. The outlook, however, has been completely altered by the administration of vitamin B₁₂, as cases have now been recorded in which the patient has been enabled to return to work, and such signs of organic nervous lesions as the extensor plantar response and sensory loss have disappeared. The blood count also returns to normal.

Treatment. Vitamin B₁₂ (cyanocobalamin) should be injected in doses of 100 micrograms every other day for a month. The dose is then gradually reduced to about 150 micrograms a month. In all cases the red cells should be maintained at 5 millions per c.mm. Folic acid should not be given as it may actually lead to neurological changes.

Friedreich's Ataxia (*Hereditary Spinal Ataxia*)

Definition. A disease characterised by ataxia, due to sclerosis of the posterior, spinocerebellar and corticospinal tracts of the spinal medulla (cord). There is a familial or hereditary tendency.

Etiology. The cause is unknown, but it may be due to a premature degeneration (abiotrophy) of certain nerve fibres. *Predisposing causes:*
1. Heredity: The disease tends to occur in several members of a family, and at times in several generations of the same family. 2. Age: Usually between 5 and 15 years; rarely it does not develop until about the age of 30. 3. Sex: Both sexes are equally affected.

Pathology. The spinal medulla (cord) may appear smaller than normal. There is atrophy of the nerve fibres of the following tracts: The posterior columns, the posterior and anterior spinocerebellar tracts, and the anterior and lateral corticospinal tracts. The dorsal nucleus (Clarke's column) is also affected. Sclerosis results from a secondary overgrowth of neuroglial tissue. The changes are most marked in the lumbo-sacral part of the spinal medulla (cord). The cerebellum is usually normal, although some cellular degeneration may occur. In some cases congenital pulmonary stenosis is also present.

Clinical Findings. The onset is insidious. The mother may notice a gradually developing deformity of her child's feet, or that there is difficulty and clumsiness in walking. The latter may be intensified in the dark.

On Examination. The nervous disease case sheet described on p. 302 can be filled in as follows:—

Case Sheet (*Friedreich's Ataxia*)

Age: 5 to 15. *Sex:* Male or female.

Cerebration: The child may be backward. *Speech:* Slurred.

Cranial Nerves. I Normal. II Optic atrophy may occur. III, IV and VI Lateral nystagmus may be present. V (a) Motor. Tremors of masticatory muscles may occur. (b) Sensory. Normal. VII (a) Motor. Twitching of the facial muscles may occur. (b) Sensory. Normal. VIII Normal. IX, X and XI Usually normal. XII Tremors of tongue may occur.

Spinal Motor Nerves. (a) Power. There is weakness of the legs and, perhaps, of the arms. (b) Wasting. This may occur late in the weak muscles. (c) Tone. The affected muscles are usually flaccid. (d) Contractions. Contractures of the foot muscles result in pes cavus, hyperextension of the big toe and hammer toes. Kyphoscoliosis is also due to muscular action. Tremors of the head, neck and trunk are often seen and intention tremors of the hands and arms, so that there is difficulty in picking up fine objects.

Spinal Sensory Nerves. (a) Cutaneous sensation: This is usually normal. It may be slightly blunted on the feet. (b) Joint sense: This is often normal, but may be lost later in the big toe. (c) Kinæsthetic sense: Often lost later. (d) Muscle and tendon sense: This may be normal or lost in the legs. (e) Nerve sensation: This is usually normal. (f) Stereognostic sense: Usually normal. (g) Vibration sense: This may be lost over the tibiæ. (h) Subjective: There are usually no pains.

The Reflexes. (a) Superficial. 1. Conjunctival and corneal: Normal. 2. Palatal: Normal. 3. Pharyngeal: Normal. 4, 5 and 6. Epigastric, abdominal and cremasteric are lost late in the disease. 7. Plantar: Extensor. (b) Deep. 1. Pupil: Reaction sluggish to light and accommodation. 2. Jaw-jerk: Not present. 3, 4 and 5. Biceps, triceps and supinator jerks may be absent. 6 and 7. Knee-jerk and ankle-jerk: Lost. (c) Visceral. Normal.

Co-ordination. There is often inco-ordination of the arms and legs, but Rombergism may not be present.

Trophic Changes. Bed sores may occur in the terminal stages. *Gait:* Reeling. The patient stands on a wide base. Static ataxia is often seen, the patient swaying when he is standing still. *Electrical reactions:* Normal. *Lumbar puncture:* Fluid normal.

Differential Diagnosis. Juvenile tabes is excluded by the familial incidence, foot deformity, extensor plantar response and absence of pupillary changes in Friedreich's disease. In multiple sclerosis the knee-jerks are exaggerated, and the age incidence is usually later. In Marie's hereditary ataxia the onset again is later, the knee-jerks are exaggerated, and there are no deformities of the feet.

Course and Complications. The course is usually slowly progressive, the patient eventually being confined to bed.

Prognosis. In some cases the disease is arrested, and frequently the patient may live for over 20 years from the onset.

Treatment. There is no known cure. The limbs should be massaged and walking exercises encouraged. Special boots are usually required.

Spinocerebellar Ataxia

(Marie's Hereditary Cerebellar Ataxia)

This disease resembles in many respects Friedreich's ataxia. The onset is usually later, generally after the age of 20 years. It shows both a hereditary and a familial incidence. There may be some degeneration of cells in the cerebellum, but the chief lesion is in the spinocerebellar tracts of the spinal medulla (cord), especially in the posterior cerebellar tract. The gait is of a reeling character, there is inco-ordination of the legs and later of the arms. The speech is slurred, and optic atrophy and nystagmus may be present. The knee-jerks are usually exaggerated. The disease differs from Friedreich's ataxia in several points, such as the absence of deformity of the feet or of kyphoscoliosis, the presence of muscular hypertonia and the exaggerated knee-jerks. Optic atrophy is more common than it is in Friedreich's ataxia. Another type of spinocerebellar ataxia is known as *Sanger-Brown's ataxia*. This also resembles Friedreich's ataxia. The chief distinguishing points of Sanger-Brown's ataxia are: Optic atrophy is generally present, there is no nystagmus and the plantar reflexes are flexor. It also usually develops at a later date than does Friedreich's ataxia.

Peroneal Muscular Atrophy

(Charcot-Marie-Tooth Type of Muscular Atrophy. Progressive Neural Muscular Atrophy)

Definition. A disease characterised by wasting of the small muscles of the feet and hands, and the muscles of the distal parts of the extremities, associated with lesions in the central nervous system.

Etiology. The cause is unknown. *Predisposing causes:* 1. There is a familial tendency and it appears to be transmitted by females. 2. Age: Between 5 and 10 years or in early adult life. 3. Sex: Males predominate slightly.

Pathology. Degeneration of the anterior horn cells occurs in the sacral, lower cervical and upper thoracic regions of the spinal medulla (cord). Degeneration may also be present in the dorsal nucleus and in the posterior and postero-lateral columns of the spinal medulla (cord). The motor nerves supplying the affected muscles atrophy, there is usually an interstitial neuritis of the branches of the common peroneal (lateral popliteal) nerve, and atrophic or fibrotic changes occur in the wasted muscles.

Clinical Findings. The disease starts gradually, the patient experiencing difficulty in walking as the feet tend to drop and become inverted. A condition of bilateral talipes equino-varus thus develops. Later, as the muscles in the legs are affected, there is greater difficulty in walking. After a few years, wasting is noticed in the intrinsic muscles of the hands, with tremors, and the muscles of the forearms are subsequently affected.

On Examination : During the active stages of the disease, fasciculations are seen in the muscles which are wasting. Contractures tend to occur, so that the feet are clubbed and the hands clawed. The thighs are not affected, except that in some cases there may be muscle wasting just above the knees ; the upper arm, trunk, neck and face muscles are unaffected. The limbs assume the shape of a bottle with the neck downwards. The knee-jerks are brisk, but the ankle-jerks are lost. The superficial reflexes are present, but the plantar response is sluggish or difficult to obtain owing to the contractures. Sensation may be normal, or there may be varying degrees of loss of cutaneous sensation over the lower parts of the arms and legs. Vibration, muscle and joint sense may also be abolished. A reaction of degeneration is usually present in the affected muscles.

Differential Diagnosis. The disease cannot be distinguished with certainty in the early stages from progressive muscular atrophy, which may start in the feet. Later, however, the characteristic distribution of the muscular atrophy establishes the diagnosis. In peripheral neuritis the onset is more acute and the sensory changes are more marked. In the distal type of myopathy of Gowers and Spiller (see p. 620) there are no sensory changes and fasciculation is not present. Claw hand and talipes equino-varus also occur in progressive hypertrophic neuritis (*Dejerine-Sottas's disease*), but here acute pains occur in the arms and legs, and the peripheral nerves are thickened and palpable.

Course and Complications. The course is usually slowly progressive over several years, but arrest of the disease then occurs, as shown by the absence of fibrillary twitching.

Prognosis. The disease is not fatal, but the affected muscles do not recover, although an improvement of function often occurs, due to the formation of fibrous tissue.

Treatment. The muscles should be massaged. Operations are contra-indicated, but light splints should be worn to help to prevent or correct deformities.

end of the first year. The muscles are flabby, but the nutrition of the infant is generally good. The muscles first affected are those of the trunk and pelvic girdle, the limb muscles proximal to the trunk are subsequently involved, and later the neck muscles; in a terminal stage the muscles supplied by the bulbar nuclei may atrophy. The infant lacks power to support itself and move as a normal child, and if it survives cannot walk at the normal age. Fasciculation is not usually seen in the affected muscles. There is loss of both superficial and deep reflexes. Sensory changes are sometimes detected.

Differential Diagnosis. When the disease is present at birth it closely resembles amyotonia congenita (see p. 630). In the latter, however, there is a tendency towards recovery.

Course and Complications. The disease is usually rapidly progressive. Pulmonary complications such as bronchitis or bronchopneumonia may develop.

Prognosis. The disease is fatal in the course of a few weeks or months.

Treatment. There is no known treatment.

THE SPINAL NERVES

Neuralgia of the Spinal Nerves

Definition. Pain along the course of a nerve, not associated with a detectable organic lesion.

Etiology. There is little distinction between neuralgia and slight degrees of neuritis, and both are probably due to similar causes. These include inflammation of the nerve sheath or sensory ganglion, anæmia, cachexia, and toxic substances such as alcohol and lead. Bacterial, viral and protozoal infections may also be associated with neuralgia, as in influenza, syphilis and malaria. Exposure to cold may also produce an attack. *Predisposing causes:* 1. Age: Usually adults. 2. Sex: Females predominate.

Clinical Findings. The patient complains of pain in the course of a spinal nerve. It often occurs in paroxysms, and may tend to recur daily at about the same time.

On Examination: Tenderness may be found at certain points on the course of a nerve, or the skin may be hyperæsthetic over the area supplied by the nerve. Certain varieties will be mentioned: *Cervico-occipital neuralgia:* Pain occurs in the region of the greater occipital nerve, over the back of the head. The skin may be very sensitive to the touch. *Brachial neuralgia:* The pain is situated in such sites as the outer part of the shoulder in the area of the circumflex humeral nerve, in the upper arm or forearm, or in the region of the median or ulnar nerves. *Intercostal neuralgia:* The pain is located to an intercostal space, and tender spots may be found at the sites of emergence of the lateral or anterior cutaneous branches (see Fig. 24A). *Crural neuralgia:* The pain occurs along the front and inner aspect of the thigh. *Sciatic neuralgia:* Here the pain is felt in the region of the sciatic nerve or its

for that of pleurisy or neuritis. The appearance of the eruption establishes the diagnosis. Herpes febrilis, which occurs in such conditions as the common cold and lobar pneumonia, does not follow a nerve distribution and attacks are liable to recur. The causative virus also differs from that of herpes zoster and it produces encephalitis when injected into rabbits.

Course and Complications. The vesicles dry up in about a week, leaving permanent scars. Severe neuralgia may occur as a complication. Lower motor neurone paresis involving the affected or adjacent segments is an occasional complication. Otic herpes may be accompanied by facial palsy, or ophthalmic herpes by oculomotor weakness, chemosis, iritis, or cyclitis. Immunity is usually conferred by one attack.

Prognosis. This is good, but in elderly people the post-herpetic neuralgia may be very intractable, causing insomnia.

Treatment. The skin lesion should be kept dry, a powder of talc and zinc oxide being applied, or, as is often more convenient, a gauze and collodion dressing. Subcutaneous injections of vitamin B₁₂, 1,000 micrograms should be given weekly for 6 weeks. Pain is relieved by such drugs as aspirin 10 gr. (0.6 G.) t.d.s. or tab. codein. co. 1 t.d.s. For post-herpetic neuralgia, treatment with X-rays to the affected region of the spine should be tried, and a sedative, such as phenobarbitone $\frac{1}{2}$ to 1 gr. (30 to 60 mg.), taken at night. In very intractable cases chordotomy, or alternatively division of the dorsal nerve root between the affected ganglion and the spinal medulla (cord), together with the roots immediately above and below may be advised. In some cases, however, these operations fail to relieve the pain, as the pain is said to be central, in the thalamus.

Radiculitis

Definition. Inflammation or degeneration of the spinal nerve roots.

Etiology. Radiculitis may be due to intervertebral disc disease, to disease of the vertebrae, such as caries or spondylitis, to meningitis due to syphilis or tuberculosis, to trauma usually produced by traction on a limb, or to the pressure of a cervical rib.

Clinical Findings. The patient complains of pain, often burning in character, which may be paroxysmal. It is usually located to a band area around the trunk or along an arm or leg.

On Examination: Hyperaesthesia is generally present in the early stages over the site of the pain. In long-standing cases the painful area may become anaesthetic. Bone vibration sense may also be lost in the affected part. Muscular wasting occurs in the groups of muscles supplied by the affected nerve roots. The cerebrospinal fluid may show an excess of lymphocytes.

Treatment. This varies with the cause and is described under the appropriate sections.

Neuritis

Definition. Inflammation or degeneration of a nerve.

Etiology. Localised neuritis may be due to various causes, such as : 1. Trauma. 2. Compression by a tumour or enlarged lymph nodes. 3. Fibrositis, involving the nerve sheath. 4. Toxins derived from micro-organisms, and possibly from the intestine. 5. Division of the nerve results in degeneration. Cold is a predisposing cause. Multiple neuritis is separately considered (see p. 452).

Pathology. In interstitial neuritis inflammatory changes occur in the connective tissue between the nerve fibres. In pressure or section neuritis there is degeneration of the nerve sheath and axis cylinders.

Clinical Findings. The clinical findings vary in different cases according to which function of the peripheral nerve is chiefly affected, and also according to the nature of the lesion. Thus the symptoms may be chiefly motor, sensory or trophic, but these are usually combined. If the nerve is irritated, as in fibrositic infiltration, the chief clinical feature is pain of a varying degree. Pain of a burning character is known as "causalgia." The muscles supplied by the nerve are tender, and often cramps, or painful muscular contractions, occur when the limb is at rest. The deep reflexes are often exaggerated. When there is more definite compression neuritis there is muscular wasting of an atrophic type with weakness. The muscles are also tender and there is alteration of cutaneous sensibility. Pain and temperature sensations are abolished over the central part of the affected area, but around this there is a zone in which touch sensation is absent, but pain is felt more acutely than normal. There is usually no reaction of degeneration. If the nerve is completely severed the muscles supplied are paralysed, flaccid and wasted, and the reaction of degeneration is present. The deep reflexes are lost. The muscles are not tender, and there is complete loss of cutaneous sensation. Trophic changes include dryness and smoothness of the skin ; a localised sweating and keratosis may occur. There may also be redness or blueness or ulceration of the skin. In *brachial neuritis* pain, numbness or tingling may be felt above the clavicle, in the axilla, arm or hand. In *ulnar neuritis* pain occurs in the arm or forearm on the medial side. The nerve is tender on pressure at the elbow. Sensation may be blunted over the medial part of the hand and the medial one and a half fingers. In *median neuritis* a severe burning pain (causalgia) may be felt in the palm of the hand, with alteration of sensation in the lateral part of the hand and lateral three and a half digits.

alimentary or renal tracts should also be made, and, if found, eliminated. Meralgia paræsthetica is described on p. 463.

Multiple Neuritis

(Polyneuritis. Peripheral Neuritis)

Definition. Inflammation or degeneration of several peripheral nerves.

Etiology. The causes, which are varied, may be grouped as follows :

1. Exogenous chemical substances, such as alcohol, arsenic, lead, mercury, copper, phosphorus, silver, gold, ether, carbon-monoxide, barbitone, etc.
 2. Toxins of micro-organisms, as in diphtheria, typhoid fever, influenza, gonorrhœa, syphilis, malaria, leprosy and tuberculosis.
 3. Deficiency diseases, such as beri-beri or lack of the vitamin B complex.
 4. Metabolic disturbances, as in diabetes mellitus, gout, anæmia, porphyria, and carcinoma. It may be met with in primary carcinoma of a bronchus or kidney and is not due to metastases.
 5. Vascular causes, such as thrombo-angiitis obliterans and polyarteritis nodosa.
 6. Acute infective or toxic polyneuritis is thought to be caused by an unknown toxin or virus.
- Predisposing causes:** 1. Age: Usually 20 to 40, but children are affected in diphtheria. 2. Sex: Equal incidence. 3. Cold and exposure may predispose. In some cases no cause is discovered.

Pathology. In long-standing cases there is parenchymatous degeneration of the peripheral nerves, usually in their distal parts. The toxin is probably carried by the blood stream, and appears to have a special affinity for certain nerves, and in some cases for certain nerve fibres in the nerves. Thus in lead poisoning the motor fibres supplying certain arm muscles are especially liable to be affected. Chromatolytic changes may also be seen in the cerebral cortical cells.

Clinical Findings. The onset is usually insidious with prodromal symptoms. Thus the patient may complain of numbness, tingling or pains in the legs or of cramps in the calves. The feet or legs may feel hot or cold. Various clinical types of neuritis exist, according to the toxic agent. Thus in lead neuritis the motor nerve fibres are affected usually in the arms, but sometimes in the legs or elsewhere. Both arms or legs are involved, the distribution of the lesion being symmetrical. The motor lesions are of the lower neurone type, there being a flaccid paralysis of certain muscles, with wasting and loss of the deep reflexes. A reaction of degeneration may be obtained. Often a mixed type of neuritis is present, with motor, sensory and possibly trophic changes. Thus in alcoholic neuritis the legs are chiefly affected. There is pain in the calves or feet with muscular tenderness. Sensory changes may be present with a stocking area of distribution. Hyperæsthesia or anæsthesia of the foot and lower part of the legs may be found. In the early stages the knee-jerks may be exaggerated but later they are lost. In diabetic neuritis trophic changes may be seen, such as a perforating ulcer or gangrene of a toe. Other trophic changes found in different types of neuritis include vasomotor disturbances, such as redness of the skin, a smooth glossy skin, absence of hair, increased sweating,

œdema, brittleness of the nails and keratoderma. Achlorhydria is present in some cases of multiple neuritis.

In acute infective polyneuritis there is a rapidly spreading paralysis involving the legs, arms and trunk. The VII cranial nerve may also be affected. There is an addition constitutional disturbance as shown by the rise of temperature. The *Guillain-Barré syndrome* (polyradiculoneuropathy) is characterised by a diffuse polyneuritis, often with bilateral facial palsy. Bulbar paralytic symptoms may develop. The cerebrospinal fluid contains an excess of protein but no cells. Fever is usually absent, except at the onset. The mortality rate varies between 8% and 30%. It may follow glandular fever, chicken-pox, herpes zoster, or contact with a cat suffering from enteritis.

Differential Diagnosis. In the motor variety of peripheral neuritis other causes of weakness and wasting of muscles must be considered. The symmetrical distribution of a lower motor neurone lesion is characteristic of peripheral neuritis. In anterior poliomyelitis the illness is acute and special groups of muscles are picked out. The temperature is also usually raised. In acute myelitis the paralysis involves the lower part of the body to a certain level; the sphincters are usually affected, which is not the case in peripheral neuritis, and sensory changes extend up to a definite segmental level. Landry's paralysis closely resembles acute infective polyneuritis. When ataxia and pains in the limbs are prominent features, tabes dorsalis may be suggested. In the latter, the anæsthetic patches on the trunk and nose, the pupil changes and the examination of the cerebrospinal fluid are diagnostic. The trophic type may suggest Raynaud's disease, erythromelalgia, acrocyanosis or syringomyelia. There are usually some motor changes present as well in peripheral neuritis, and the stocking and glove distribution of sensory changes is suggestive of peripheral neuritis.

Course and Complications. The course is usually chronic, the symptoms lasting several months. In acute infective polyneuritis the course is, however, more rapid. Mental changes, such as Korsakow's psychosis (see p. 704), are especially liable to occur in association with alcoholic neuritis. Myocardial degeneration may also be present, particularly in diphtheritic neuritis and in beri-beri. Permanent contracture of the antagonistic muscles may ensue.

the whole vitamin B complex is of doubtful value in alcoholic neuritis. Electrical treatment by diathermy is of value in some cases for the relief of pain. As the pain subsides the muscles should be gently massaged. In the *Guillain-Barré syndrome* good results may be obtained by the administration of 6-mercaptopurine in doses of 25 mg. b.i.d. by mouth for 3 or 4 weeks.

Tumours of Nerves

Etiology. The cause is unknown.

Pathology. The tumour may be a neuroma, a fibroma or sarcoma. Single or multiple tumours may be met with. The true neuroma consists of nerve ganglion cells or nerve fibres, and occurs in the sympathetic system. The perineural fibroblastoma arises from the nerve sheath. When appearing on cutaneous nerves they are known as molluscum fibrosum, and if, in addition, there is pigmentation of the skin, they constitute von Recklinghausen's disease.

Clinical Findings. Nerve tumours may give rise to no symptoms. If attached to the dorsal nerve roots, they may cause pain, or muscular weakness if they arise from the ventral nerve roots. When situated under the skin they are usually tender to pressure (*tuberculosa dolorosa*).

Treatment. If the tumour is causing symptoms and is accessible, it should be removed surgically.

The Cervical Plexus and its Branches

Anatomy. The cervical plexus is formed from the ventral rami of the upper four cervical nerves.

The Phrenic Nerve

Anatomy. The phrenic nerve is formed from C. 3, C. 4 and C. 5 nerves, chiefly from C. 4. It passes down the neck over the scalenus anterior muscle, and after traversing the thorax supplies the diaphragm.

Etiology of Lesions. Lesions may be due to: 1. Trauma, such as a wound in the neck. 2. Pressure, as by arthritis or fracture of the spine, enlarged lymph nodes, a mediastinal tumour or abscess, or a pericardial effusion. 3. Nervous diseases, such as spinal meningitis, poliomyelitis, hæmorrhage of the spinal medulla (cord), Landry's paralysis, neuritis, or a tumour.

Clinical Findings. Often no abnormal physical signs can be detected. Thus the movement of the lower part of the chest and of the upper part of the abdomen appears normal. The air entry at the base of the lung on the affected side is often weaker owing to the fibrosis of the lung. X-ray examination shows the diaphragm on the affected side raised 1 to 2 inches (2.5 to 5 cm.) and motionless, or exhibiting paradoxical movement (see p. 215). In cases of paralysis of the diaphragm by enlarged lymph nodes due to malignant disease reversal of diaphragmatic movement may occur on the affected side, the paradoxical movement showing the affected half of the diaphragm to ascend with

first drooping of the shoulder, then compression of Th. 1 root and the subclavian artery between the normal first rib and the clavicle. This leads to scalenus anterior spasm. The term *thoracic inlet syndrome* is non-committal as regards etiology, and so preferable. It is not uncommon in women who have to carry heavy shopping bags. Acroparæsthesia of the hands and arms, observed chiefly in middle-aged and elderly women who have to perform unusual manual work, may be due to the same cause. The patient complains of burning pain, tingling, sagging of the shoulder, numbness and uselessness, and, at times, pallor or blueness of the fingers, worse at night.

Differential Diagnosis. This is established by X-ray examination, but care should be taken to exclude other diseases, causing muscle wasting of the hand, such as syringomyelia and progressive muscular atrophy.

Treatment. If the cervical rib is giving rise to definite symptoms, it should be removed surgically. In the thoracic inlet syndrome the affected arm should be rested in a sling. In more advanced cases the subclavian artery may be freed, by division of the scalenus anterior, and the brachial plexus by division of the first rib. For acroparæsthesia, the only treatment that affords relief is rest; electrical treatments are useless.

The Long Thoracic Nerve

(The Nerve of Bell)

Anatomy. The long thoracic nerve arises from the C. 5, C. 6 and C. 7 nerve roots as they traverse the intervertebral foramina. It passes through the scalenus medius muscle to the axilla and to the outer side of the serratus muscle, which it innervates.

Etiology of Lesions. The long thoracic nerve may be affected by :
1. Trauma, by a wound in the neck or axilla, or by carrying heavy weights on the shoulder, as may occur with porters. 2. Neuritis, in influenza or diphtheria. 3. A spinal medulla (cord) or cerebral lesion, in progressive muscular atrophy.

Clinical Findings. The patient finds that his upper arm and shoulder are weak. Thus there is difficulty in elevating the arm above the level of the horizontal, and in pushing with the arm.

On Examination : When the arm is by the side the scapula on the affected side is higher than the other one, and the inferior angle is nearer the spine. If the patient is asked to hold his arms out in front of him and the back is inspected, there is prominence of the medial border of the scapula (winging of the scapula) on the affected side.

The Circumflex Humeral Nerve

Anatomy. The circumflex humeral nerve arises from the posterior cord of the brachial plexus from the C. 5 and C. 6 nerves. It travels behind the axillary artery, and winds round the surgical neck of the humerus to supply the deltoid and teres minor muscles. It also gives a

branch to the shoulder joint, and a cutaneous nerve to the skin of the upper and outer half of the arm.

Etiology of Lesions. The circumflex humeral nerve may be affected by : 1. Trauma, in dislocation or fracture of the shoulder or by the pressure of a crutch. 2. Arthritis and bursitis of the shoulder. 3. Neuritis, in fibrositis, diabetes mellitus or exposure to cold.

Clinical Findings. The patient complains of pain in the region of the shoulder and the outer and upper part of the arm. He may also experience difficulty in raising the arm or rotating it outwards.

On Examination : Flattening of the shoulder may be seen, owing to wasting of the deltoid. There is some blunting of sensation over the upper and lateral part of the arm. The pain may encircle the upper part of the arm like a hot wire, completely preventing sleep, and it is always worse when the patient is in bed. In long-standing cases adhesions may form in the shoulder joint.

The Radial Nerve

Anatomy. The radial nerve is formed from the posterior divisions of C. 5, C. 6, C. 7, C. 8 and Th. 1 nerve roots.

At first the nerve lies behind the axillary artery, and in the upper third of the arm it passes behind the brachial artery on the medial side of the arm. In the middle third of the arm it passes behind the humerus, and reaches the lateral side of the humerus in the lower third of the arm, entering the forearm by passing in front of the lateral epicondyle of the humerus. It then gives off the posterior interosseous nerve. The radial nerve supplies the triceps, anconeus, brachioradialis, extensor carpi radialis longus and the brachialis muscles. The cutaneous branches include the posterior cutaneous and the lower lateral cutaneous nerves of the arm and the posterior cutaneous nerve of the forearm. It also supplies the skin over the back of the wrist, the lateral side and back of the hand, the back of the thumb and the lateral side of the index finger and the adjoining sides of the index and middle fingers and of the middle and ring fingers.

The Posterior Interosseous Nerve. This runs round the lateral side of the radius to reach the back of the forearm, and travelling deep to the extensor tendons ends on the back of the carpus. It supplies the following muscles: The extensor carpi radialis brevis, supinator, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis and the extensor indicis.

Treatment. The forearm and hand should be supported on a splint, with the wrist and fingers slightly extended.

The Ulnar Nerve

Anatomy. The ulnar nerve is formed from the C. 8 and Th. 1 nerve roots from the medial cord of the brachial plexus. It passes in the axilla between the axillary artery and vein. In the upper half of the arm it lies in front of the triceps muscle medial to the brachial artery. At the elbow it is placed between the medial epicondyle of the humerus and the olecranon. In the forearm it lies between the flexor carpi ulnaris and flexor digitorum profundus muscles, and passing in front of the flexor retinaculum into the palm of the hand it divides into a superficial and deep branch. There are no branches in the upper arm. In the forearm the following branches arise: Muscular, to the flexor carpi ulnaris, and medial half of the flexor digitorum profundus muscles. Cutaneous: (a) Palmar, to the palm of the hand and hypothenar eminence; (b) Dorsal, to the back of the wrist and hand, the medial side of the little finger and the adjacent sides of the little and ring fingers. The superficial terminal branch supplies the palmaris brevis and the skin of the palmar surface of the medial side of the little finger and the adjacent sides of the little and ring fingers. The deep terminal branch is distributed to the following muscles: The flexor brevis digiti minimi, the abductor digiti minimi, the opponens digiti minimi, the interossei, the third and fourth lumbricals, the adductor pollicis, and the flexor pollicis brevis.

Etiology of Lesions. The ulnar nerve may be affected by: 1. Trauma, such as a wound or injury of the arm or elbow. 2. Neuritis, due to cold or to leprosy.

Clinical Findings. If the lesion is situated near the elbow the patient notices weakness in flexing the wrist.

On Examination: There may be radial deviation and extension at the wrist joint, the fingers are extended at the metacarpo-phalangeal joints, but flexed at the interphalangeal joints, especially the two inner fingers. There is inability to adduct the thumb and the patient cannot separate the fingers. With a lesion at the wrist a claw hand develops, there is wasting of the hypothenar eminence and of the spaces between the metacarpal bones. There is also loss of sensation over the inner one and a half fingers.

Treatment. The arm should be rested, and the forearm and hand supported in a splint.

The Median Nerve

Anatomy. The median nerve is formed from the lateral and medial cords of the brachial plexus, from the C. 5, C. 6, C. 7, C. 8 and Th. 1 nerve roots.

The median nerve passes down the front of the arm on the lateral side of the brachial artery, and in the lower third of the arm crosses in front of the artery to its medial side. It reaches the forearm between the two heads of the pronator teres muscle. It runs down the middle

of the forearm deep to the superficial muscles and enters the palm on the lateral side of the flexor tendons of the fingers. There are no branches in the arm. In the forearm it gives off the anterior interosseous and the palmar cutaneous branches. The anterior interosseous nerve gives branches to the flexor pollicis longus, and the lateral half of the flexor digitorum profundus and the pronator quadratus muscles. The palmar cutaneous branch supplies the skin of the palm. The median nerve in the hand supplies the following muscles: The abductor and opponens pollicis, the superficial head of the flexor pollicis brevis and the two lateral lumbricals. The cutaneous branches are distributed to both sides of the thumb, the lateral side of the index finger, and the adjacent sides of the second and third, and third and fourth fingers.

Etiology of Lesions. The median nerve may be affected by:

1. Trauma, such as a wound in the arm or forearm. 2. Pressure, as by contractions of the two heads of the pronator teres in playing tennis ("tennis elbow"), or continued use of the arm, as in dentistry. 3. The median nerve may be compressed in the carpal tunnel (See below.)

Clinical Findings. If the lesion occurs above the elbow, there is weakness in pronating the forearm and in flexing the wrist and the interphalangeal joints. The thumb also cannot be abducted. The hand is deviated to the ulnar side. When the lesion is located at the wrist there is wasting of the thenar eminence and inability to abduct the thumb. Loss of sensation in both lesions is found over the thumb and the two and a half outer fingers. The patient often complains of severe burning pain (causalgia) in the hand when the nerve is incompletely divided. Trophic changes appear in the hand, redness, sweating, a glossy skin, overgrowth and curving of the nails, wasting of the finger pads, swelling of the joints and fragility of bones.

Treatment. The arm should be rested in a sling and the thumb muscles prevented from stretching by an adequate splint. Procaine block of the sympathetic, or sympathectomy may be required for causalgia.

The Musculocutaneous Nerve

Anatomy. The musculocutaneous nerve arises from the lateral cord of the brachial plexus, from the C. 5, C. 6 and C. 7 nerves.

The musculocutaneous nerve passes down the arm between the biceps and brachialis muscles to the elbow. It supplies branches to these two muscles and to the coracobrachialis. In the forearm it supplies the skin on the outer and posterior aspect.

Etiology of Lesions. The nerve may be injured by trauma or involved in a neuritis.

Clinical Findings. The patient has difficulty in flexing the forearm, and sensation may be lost over the outer side and back of the forearm.

Cervical Spondylosis

Definition. A condition characterised by degenerative changes in the cervical intervertebral discs and vertebrae, accompanied by cervical radiculitis and at times by cervical spinal medulla (cord) compression.

Etiology. The cause is unknown. In some cases cervical spondylosis follows trauma to the neck which may not have been recognised at the time. It may be due to whiplash injury to the neck, caused usually by a car collision from behind, or it may follow a strain of the neck under an anæsthetic due to faulty position.

Pathology. The most important lesion is compression of the cervical nerves in the intervertebral foramina. Less often the nerve roots are compressed before they enter the foramina, or the spinal medulla (cord) is compressed. The pathological changes include disc degeneration and narrowing, which limit flexion and extension of the spine and shorten the spine. The intervertebral foramina are thus narrowed from above downwards and the nerve roots may be kinked. The disc may protrude or it may rupture. Pressure may thus occur on the nerve in the foramen, on the spinal nerve root or on the spinal medulla (cord). Osteophytes may form on the neuro-central joints partially obliterating the intervertebral foramina, or intraspinally compressing the spinal medulla (cord), or on the anterior surface of the body of the vertebra impinging on the œsophagus. Finally, fibrotic changes may compress the nerve roots and radicular nerves. In some cases the vertebrae become fused, in others they are unduly mobile, with spondylolisthesis.

Clinical Findings. A disc may rupture suddenly causing severe pain in the neck, with limitation of movement. Usually the onset is insidious with *nerve root symptoms*. Pain radiates to the shoulder, arm, hand, digits, and may be felt in the upper interscapular region, or in the upper part of the front of the chest. The trapezius muscle may go into spasm on one side. In some cases pain radiates to the side of the neck, to the teeth, or to the ears. Paræsthesia is often an early symptom, burning or tingling sensations in the fingers, or there may be numbness and difficulty in picking up small objects. The radial side of the arm and hand is more often affected than the ulnar. Pressure of osteophytes on the œsophagus may cause dysphagia. Some patients complain of

The Lumbosacral Plexus and its Branches

Anatomy. The lumbosacral plexus is formed from the anterior primary divisions of the 1st to 5th lumbar and 1st to 4th sacral nerves.

The Femoral Nerve

Anatomy. The femoral nerve is derived from the dorsal branches of the ventral rami of the L. 2, L. 3 and L. 4 nerves. It supplies muscular branches to the iliacus, pectineus, sartorius and quadriceps femoris muscles. The sensory branches are the intermediate and medial cutaneous nerves passing to the anterior and medial side of the thigh, and the saphenous nerve supplying the medial side of the leg and foot.

Etiology of Lesions. The femoral nerve may be affected by : 1. Trauma, in fracture of the pelvis or femur, or by wounds in the groin. 2. Pressure, due to a prolapsed intervertebral disc between L. 3 and L. 4, to a psoas abscess, a tumour of the pelvis, enlarged inguinal lymph nodes, or an aneurysm of the iliac artery. 3. Arthritis of the spine or hip. 4. Neuritis due to diabetes mellitus. 5. Neuralgia associated with chronic constipation.

Clinical Findings. An organic lesion of the femoral nerve gives rise to weakness of the thigh, the patient complaining that his knee lets him down.

On Examination : There is weakness and wasting of the extensors of the knee and slightly of the hip flexors. The affected muscles are flaccid. Tenderness may be found on pressure on the medial side of the thigh. The knee-jerk is diminished or absent, and the quadriceps femoris muscle may show a reaction of degeneration. There may be anaesthesia or paræsthesia over the medial side of the thigh or leg. In crural neuralgia there is pain on the medial side of the thigh or leg and the medial side of the foot. In all cases a rectal examination should be made to exclude a growth, together with an X-ray examination of the pelvis and spine.

Prognosis and Treatment. These vary with the cause. In cases due to neuritis the treatment consists in rest and light massage. Support may be given to the knee by an elastic band passing down the front of the thigh and attached above to a belt on the thigh and below to a garter around the calf.

The Obturator Nerve

Anatomy. The obturator nerve is derived from the ventral branches of the ventral rami of L. 2, L. 3 and L. 4 nerves. The anterior branch supplies the adductors of the thigh, and the skin over the medial part of the lower two-thirds of the thigh. The posterior branch supplies the obturator externus muscle (an external rotator of the thigh) and the knee-joint.

Etiology of Lesions. The nerve may be injured in women during labour, or by the pressure of a pelvic tumour or an obturator hernia.

Clinical Findings. In obturator neuralgia there is pain over the medial side of the thigh. When the nerve is definitely injured by pres-

sure there is weakness of the thigh adductors, as shown by difficulty in crossing the leg, and weakness in external rotation of the hip may also be detected. There may be blunting of sensation over the lower part of the side of the thigh.

Treatment. This varies with the cause.

The Lateral Cutaneous Nerve

Anatomy. The lateral cutaneous nerve is derived from the dorsal branches of the ventral rami of L. 2 and L. 3 nerves. It enters the thigh close to the anterior superior iliac spine, beneath the inguinal (Poupart's) ligament. It is a sensory nerve which supplies the skin on the lateral side of the thigh and below the great trochanter of the femur.

Etiology of Lesions. Lesions may be due to trauma, to pressure in pregnancy, to neuritis, or to local fibrositis in the tunnel of the fascia lata.

Clinical Findings. Neuritis of the lateral cutaneous nerve is known as *meralgia paræsthetica*. It is generally caused by tension of the overlying fascia. It usually affects obese, middle-aged men but it may occur during pregnancy. It begins with a sense of numbness over the antero-lateral aspect of one thigh. Later there is burning, tingling and pain, worse on standing or walking. A tender spot may be found at the lateral end of the inguinal ligament, where the nerve enters the thigh.

Treatment. In some cases it is advisable to excise the nerve to relieve pain.

digitorum longus and flexor hallucis longus) and cutaneous branches to the lateral side of the back of the leg, the heel and back of the sole of the foot. *The medial plantar nerve.* This supplies muscular branches to the abductor hallucis, flexor hallucis brevis, flexor digitorum brevis and first lumbrical muscles, and cutaneous branches to the medial side of the sole of the foot, and the plantar surface of the medial three and a half toes. *The lateral plantar nerve.* This supplies the remaining small muscles of the foot, and cutaneous branches to the lateral side of the sole of the foot, and the plantar surface of the lateral one and a half toes.

Etiology of Lesions. The sciatic nerve may be affected by inflammatory changes of the spine or meninges at its origin from the spinal medulla (cord), by a spinal tumour or prolapsed intervertebral disc. In the pelvis it may be involved in a fractured pelvis, or by a tumour, or the pregnant uterus. At the sciatic notch or in the thigh it may be injured by a wound or involved by inflammation of its sheath. The common peroneal (lateral popliteal) nerve is liable to injury, and it may be affected in lead neuritis and in leprosy. The tibial (medial popliteal) nerve is rarely affected.

Clinical Findings. *Lesions in the pelvis or thigh :* These result in paralysis of the hamstrings and all the muscles below the knee. There is inability to flex the knee and the foot is dropped. The patient can neither stand on his heel nor on his toes, but he can usually walk. There is loss of the ankle-jerk, and anæsthesia is found over the foot and the lower two-thirds of the calf. *Lesions of the common peroneal nerve :* The foot is dropped and inverted ; the toes are flexed and cannot be extended. The patient can stand on his toes. There is anæsthesia on the lateral half of the front of the leg and on the dorsum of the foot and adjacent sides of the toes. *Lesions of the tibial nerve :* The patient cannot extend his foot and cannot flex the toes. He cannot stand on his toes. There is anæsthesia on the lower third of the lateral and posterior part of the leg, and the sole of the foot and plantar surface of the toes. Later, contracture may occur causing a claw foot.

Sciatica

Definition. Three conditions are commonly included in the term sciatica. 1. Interstitial neuritis of the sciatic nerve. 2. Symptomatic sciatica in which the nerve is involved by compression or by extension of an inflammatory process. 3. Pain referred along the sciatic nerve which itself is not involved in any pathological process.

Etiology. Some authorities deny the existence of sciatic neuritis, but interstitial neuritis may be due to some toxi-infective condition such as focal sepsis, rheumatism, alcoholism, diabetes mellitus, syphilis, etc. Symptomatic sciatica is commonly due to fibrositis spreading from adjacent muscles and fasciæ to involve the sheath of the sciatic nerve. Other causes include spinal medulla (cord) tumour, trauma, spinal caries, spondylitis, meningitis, fractured pelvis, prolapsed intervertebral disc, a pelvic tumour, etc. It does not follow that osteoarthritis of the spine, as revealed by X-ray examination, is necessarily

the cause of sciatica in an individual case. Pain may be referred reflexly along a healthy sciatic nerve from osteoarthritis of the hip, sacro-iliac strain, etc. *Predisposing causes:* 1. Age: Usually over 20 years. 2. Sex: Males predominate. 3. Strain of the muscles of the back. 4. Chill, as by sitting on wet grass.

Clinical Findings. In the type which is secondary to fibrositis of the lumbar and gluteal muscles, the onset is usually insidious. The patient is an adult who gives a history of straining his back, as by digging or by lifting. Pain and stiffness are felt across the small of the back. The patient may pay no attention to it and strain his back still further. Indications that the inflammation has spread to the sheath of the sciatic nerve are afforded later, perhaps after 1 or 2 months. There is a sensation of numbness or tingling, often felt in the heel when the foot is first put to the ground after resting. This may quickly pass off and recur from time to time. Further, on sitting a sensation of numbness may be felt in the back of the thigh or in the leg, as if the leg has "gone to sleep." Later, pain may be experienced either in the back of the thigh or in the leg. This may also be transient and not give rise to any anxiety. If the disease progresses the pain becomes more acute and more persistent. The patient finds that he cannot sit on any ordinary chair with comfort, the weight is put on the sound side and a soft cushion is welcomed. On lying he is usually free from pain, but twitching or cramps may occur in the calf muscles and disturb sleep. Later, the pain may be more acute and disturb sleep. The patient then usually prefers to lie on his back, with the hip and knee flexed and the ankle plantar-flexed. It is very difficult for him to turn over on his face owing to pain. If he lies on his side, it is usually on the affected side, because lying on the sound side causes a drag in the gluteal region on the affected side. Walking now becomes difficult, the hip and knee are kept slightly flexed and the heel is not put to the ground. The pain in sciatica can be very acute, of a deep-seated burning and boring nature, causing considerable exhaustion.

On Examination: In a developed case definite signs are present. *Spinal motor system:* The affected leg. (a) Power: This is usually normal, but some weakness of the knee flexors or leg muscles may develop later. (b) Tone: There is flaccidity of the affected muscles. (c) Wasting: This is often present in the calf and thigh, and the gluteal fold is much diminished. (d) Contractions: Fasciculation and cramp may occur in the calf muscles.

placed under the lower part of the abdomen, often reveals the presence of the so-called fibrous nodules in the lumbar and gluteal muscles. These are thought to be lipomatous protrusions through the fascia and are tender on pressure. In cases due to a pelvic tumour, rectal examination may reveal the cause, and this should be carried out in every case of sciatica. A sarcoma of the ilium may be obvious on external examination of the back. An X-ray examination should always be made of the spine and pelvis, including the hip joint, as in this way arthritis may be detected. The urine should also always be tested for glucose. Bilateral sciatica is very suggestive of a pelvic tumour, but it may occur in diabetic or in fibrositic sciatica. In some cases fibrositic sciatica has an acute onset.

Differential Diagnosis. Some authorities consider that a severe case of sciatica, as described above, is due to a prolapsed disc, but in the latter the pain is usually more acute at the onset and the back may feel as if it is broken across. In arthritis of the hip there is some limitation of movement of the joint and the X-ray findings are usually diagnostic. Prolapse of an intervertebral disc is considered on p. 467.

Course and Complications. Sciatica usually pursues a prolonged course lasting several months or 1 or 2 years, but the ultimate tendency is to recovery. Recurrences undoubtedly occur in the same leg. After a severe attack the sciatic nerve remains a weak spot in the body, and any violent strain may provoke another attack. Permanent muscular wasting and diminution of the ankle-jerk are liable to remain. The course in pressure sciatica is progressive unless the cause is removed.

Prognosis. The outlook is usually good in sciatica, but in pressure sciatica the prognosis is generally unfavourable, unless it is due to a simple tumour, which can be removed.

Treatment. The sooner the patient takes to his bed the sooner a fibrositic sciatica will be cured. Constipation must be adequately treated. The teeth should be X-rayed, and if any apical infection is present it should be treated. The blood Wassermann reaction should be determined, and if positive a course of anti-syphilitic treatment should be given. If diabetes mellitus is found, it will be necessary to administer insulin and a correct diet. Local treatment consists in the application of heat to the leg, either by hot bottles, or by diathermy. If tender "fibrositic" nodules are found in the gluteal muscles they should be injected with 20 to 40 ml. of 1% procaine. The injection may be repeated next day and again after a day's interval, and in some cases the sciatic pain is quickly relieved. No violent massage or nerve stretching should be employed, as this only does harm and aggravates the sciatica. If the pain is severe the affected limb should be immobilised in plaster. Analgesics such as aspirin 10 to 15 gr. (0.6 to 1 G.) or tab. codein. co. nocte will usually secure sleep. High sciatica may be treated by epidural injections if other measures fail. These consist in the injection through the sacro-coccygeal foramen of 20 ml. of 1% procaine solution and 60 ml. of normal saline. The patient should lie down for a day or so after the injection.

CHAPTER V

THE URINARY SYSTEM

Introductory. Clinical examination in diseases of the urinary system implies far more than an examination of the urine. The cardio-vascular system, the blood and the tissue fluids are intimately linked with this excretory system. Information may be required on the following points: *The urine*: The colour, reaction, and odour. The amount and specific gravity, by day and night. The consistency and deposit. *Chemical examination*: Proteins, albumin, globulin, Bence Jones protein, albumose, and hæmoglobin derivatives, such as methæmoglobin and porphyrin. Bile salts and pigment. Reducing substances, such as glucose, lactose, pentose, creatinin, uric acid, and homogentisic acid. *Chlorides. Microscopical examination*: Blood cells (red and white), pus cells, renal or vesical epithelium, casts, crystals, phosphates, uric acid, urates, oxalates, cystine, leucine and tyrosine. In acid urine the following crystalline substances may be found: Uric acid, sodium urate, hippuric acid, calcium oxalate, cystine, xanthine, leucine and tyrosine. In alkaline urine crystals include calcium phosphate (stellar phosphate), ammonium magnesium phosphate, ammonium urate, calcium carbonate, and cholesterolin. Bacteria, such as the *E. coli*, the *Mycobacterium tuberculosis*, staphylococci and streptococci. Ova, such as those of the *Bilharzia*. *The blood*: Chemical examination: Total protein, albumin and globulin, urea, non-protein nitrogen, cholesterol, and chlorides. Blood counts. Wassermann reaction. *The cardio-vascular system*. The size of the heart; valvular or myocardial lesions; the condition of the aorta and peripheral vessels; the blood pressure and ophthalmoscopic examination.

Abnormalities of the Urine

Amount. The amount of urine passed in the 24 hours by an adult averages 50 fl. oz. (1.5 litre)—37 fl. oz. (1.1 litre) by day and 13 fl. oz. (0.4 litre) by night. This volume may be increased or decreased.

Polyuria. This is a symptom of many conditions, such as: Nervousness, cold, over-drinking, diuretics, such as tea, beer, etc., diseases such as diabetes insipidus, diabetes mellitus, chronic nephritis, and hyperpiesis.

Oliguria and Anuria. Oliguria may be due to various causes, such as: Scanty intake of fluids, exercise, sweating, hysteria, acute nephritis, and fevers. Anuria may result from: 1. Suppression, no urine being formed. This may be due to the acute or the terminal stages of nephritis, severe shock and collapse as in coronary thrombosis or cholera. It may also result from shock due to operations or hæmorrhage, or be due to a mismatched blood transfusion, passing a catheter, a soap-induced abortion or mercury poisoning. 2. Obstruction. This may be due to

stricture, an enlarged prostate, carcinoma of the bladder blocking the orifices of the ureters, calculi in both ureters, a calculus obstructing one ureter, the other kidney having been removed, or removal of the sole functioning kidney.

Specific Gravity. Normally this varies by day and night, being by day 1.018 and by night 1.026. The specific gravity of a single specimen is valueless as a clinical guide, at least a 12 hours' specimen is required.

Colour and Consistency. The colour may be pale in a low specific gravity urine, as in chronic nephritis, or in a high specific gravity urine, as in diabetes mellitus. The urine may be turbid or show a deposit, due to: Urates, phosphates, mucin, pus, and organisms. Various colours may be noted, such as: Brown, due to bile or to urates; red, owing to blood or its derivatives or to Pyridium when the urine is acid.

Some individuals have an idiosyncrasy towards beetroot, and pass red urine 4 to 6 hours after taking it. The urine is clear, turns yellow with alkali, and red again with hydrochloric acid. No absorption band is seen spectroscopically. The faeces may be red or purple, and there may be diarrhoea.

The urine may be bright yellow, due to riboflavin; black, due to melanin, carbolic acid, and alkapton; white, from chyle; green, from bile, methylene blue, and carbolic acid; pink, from a deposit of urates; blue, due to methylene blue; orange, from excess of urobilin, santonin or rhubarb. The urine may also be green (verdoglobinuria) in patients suffering from burns who are threatened with *Pseudomonas septicæmia*. The urine may be frothy, due to gas.

normal. The cause of the condition is not known, but the patient usually grows out of it, although it may last in about one-fifth of the cases until the age of 30. It has been suggested that it is due to lordosis. It does not lead to subsequent renal disease. Administration of calcium lactate 10 to 15 gr. (0.6 to 1 G.), or of sodium bicarbonate 60 gr. (4 G.) t.d.s. may cause the proteinuria to disappear temporarily. Violent exercise, such as rowing a course, leads to a temporary proteinuria in the majority of adult athletes. Postural proteinuria may also occur after infections, such as scarlet fever, no proteinuria being passed as long as the patient remains in bed.

Organic Proteinuria. *Renal causes:* Nephritis, nephrosis, passive congestion (cardiac kidney), infarction, tuberculosis, polycystic disease, malignant tumours, amyloid degeneration, papilloma of the renal pelvis, pyelitis, and calculus. *Ureteric causes:* A stone. *Vesical causes:* Cystitis, new growths, calculus, and tuberculosis. *Urethral causes:* Urethritis and prostatitis.

Febrile proteinuria may occur in any condition in which there is moderately high pyrexia, and is probably a manifestation of the toxæmic kidney (see p. 488).

Albumosuria

This may appear during the resolution period of lobar pneumonia, in acute massive necrosis of the liver, during the puerperium, or in chronic suppuration. Bence Jones protein is associated with multiple myelomata.

Phosphaturia

The urine is alkaline. The phosphates may only be seen on boiling, or they constitute a whitish opacity, often noticed at the end of micturition, and mistaken by the male patient for semen. In such instances depression, neurasthenia, or wasting may be noted. The condition is often associated with cystitis, due to a staphylococcus infection, or it may result from overdosage with alkalis in the treatment of peptic ulcer, or from a vegetable diet. A specimen removed under aseptic conditions should be examined microscopically and the presence of crystals and organisms determined.

Treatment. This consists in giving acid sodium phosphate in doses sufficient to keep the urine acid; as much as 60 gr. (4 G.) t.d.s. may be required. Sulphonamides or antibiotics, according to the sensitivity of the organism, may also be given. A diet poor in calcium-containing substances is recommended, milk and eggs being avoided.

Oxaluria

This is detected on microscopical examination of the urine. It is usually of no clinical significance, but in some instances it is associated with recurrent hæmaturia or with pain suggesting renal calculus or spinal disease. Colonic flatulence due to carbohydrate indigestion may be the chief symptom.

Treatment. Diet: Strawberries, rhubarb, tomatoes, beetroot,

spinach, cabbage, radishes, cauliflower, Brussels sprouts, eggs and milk, should be avoided as they are rich in oxalates and lime. The following substances which contain magnesium salts may be taken: Potatoes, bread, meat, apples and peas. The diet should be rich in protein and excess of carbohydrate should be avoided, especially root vegetables and porridge. Acid sod. phosph. 30 to 60 gr. (2 to 4 G.) t.d.s. and mag. sulph. 60 to 120 gr. (4 to 8 G.) should be given in the morning. Hard water should not be drunk.

Glycosuria

The following substances which reduce Fehling's solution may be found in the urine: Glucose, lactose, pentose, homogentisic acid, urates, and creatinin. Benedict's solution is only reduced by glucose, lævulose, lactose, pentose and homogentisic acid. Glucose is of the greatest clinical importance and is considered under diabetes mellitus.

Acetonuria

This is met with in acidosis, associated with diabetes mellitus, Von Gierke's disease, prolonged vomiting and starvation.

Indicanuria

This can only be detected by chemical tests; an excess is indicative of intestinal stasis.

Hæmaturia

Definition. The presence of red blood cells in the urine.

Etiology. The causes are very numerous, and may be thus subdivided: 1. *Renal causes*: Nephritis, infarction, tuberculosis, calculus, crystals such as oxalates or the acetyl derivatives of sulphonamides, turpentine, cantharides, carbolic acid, congestion, movable kidney, pyelitis, injury, papilloma, neoplasms, polyarteritis nodosa, and polycystic disease. 2. *Ureteric causes*: Calculus. 3. *Vesical causes*: Calculus, papilloma, carcinoma, tuberculosis, bilharziasis, acute cystitis, arteriosclerosis, and varicose veins. 4. *Urethral causes*: Trauma, urethritis, ulcerating growths, and caruncle. 5. *Prostatic causes*: Enlargement and growths. 6. *Pre-renal causes*: Leukæmia, purpura, scurvy, hæmophilin, a low plasma prothrombin content, malignant varieties of small-pox, and scarlet fever.

Clinical Findings. The colour of the urine varies with the amount of blood present; it may be almost black, or present a smoky appearance, or show a dark ring on top. In other cases it is faintly tinged. With small amounts of blood there are no naked-eye changes, but the presence of blood cells is detected microscopically. If the blood is intimately mixed with the urine on passing, it is probably derived from the kidneys; if it appears only at the beginning of micturition it probably comes from the urethra, and if it is noticed at the end of micturition the source may be in the bladder. A case of hæmaturia may be investigated on the following lines: General examination of the patient for fever, purpura and scurvy. Examination of the heart

and arteries in cases of nephritis. Examination of the urine: Amount, casts, crystals, cells, organisms, and ova. This will yield suggestive information as to nephritis, oxaluria, pyuria, infections such as tuberculosis, pyelitis, cystitis, and bilharziasis. Examination of the blood: Blood count, blood culture, Wassermann reaction, plasma prothrombin concentration, blood urea and non-protein nitrogen. These tests will be of help in leukæmia, septicæmia, syphilis, and chronic nephrosclerosis. X-ray examination for stone in the kidneys, ureter, or bladder. Cystoscopy and catheterisation of the ureters, and pyelography. This will show whether the blood is coming from the bladder or from one or both ureters. Blood coming from one kidney may mean a very early stage of chronic nephrosclerosis or an angioma at the apex of a pyramid, in addition to other causes such as tuberculosis, tumours, calculi, etc. Pyelography is of value in indicating the presence of a tumour deforming the pelvis of the kidney or ureter, or a hydronephrosis. Despite all these investigations in some cases the cause of bleeding cannot be determined, and such cases are known as "renal epistaxis" or the essential hæmaturia of Gull. Certain of these cases are due to local purpuric lesions in the kidney or renal tract.

Treatment. This is considered under the various causative conditions.

Hæmoglobinuria

Definition. The presence of blood pigments, especially methæmoglobin in the urine.

Etiology. Hæmoglobinuria results from intravascular hæmolysis. This may be due to: 1. Chemical substances, such as potassium chlorate, arsine, muscarine, sulphonamide, quinine and mephenesin (Myanesin). 2. Infective agents, such as cause syphilis, malaria (black-water fever), yellow fever, and gas gangrene due to the *Clostridium welchii*. 3. Mis-matched blood transfusions. 4. Fabism, idiosyncrasy to the broad bean (*vicia faba*), due to deficiency of an enzyme, glucose-6-phosphate dehydrogenase, concerned in red cell glucose metabolism. In patients with this genetic abnormality aspirin, phenacetin, primaquine, etc. may produce hæmolysis. 5. Pregnancy and the puerperium. 6. Extensive burns. 7. Lederer's anæmia. The cause of this is unknown. 8. Spider bites. A case has been recorded in America resulting from the bite of a large brown spider. 9. Paroxysmal hæmoglobinuria results from (a) exposure to cold. It may occur in viral pneumonia due to cold agglutinins in the blood, and also after mumps. (b) muscular exercise or standing in a position of lordosis, (c) hæmolytic anæmia producing nocturnal hæmoglobinuria (the Marchiafava-Micheli syndrome), (d) paralytic hæmoglobinuria, or paroxysmal myoglobinuria.

The primary abnormality in the Marchiafava-Micheli syndrome lies in the red corpuscles, as shown by the acid serum test of Ham. A certain number of the patient's red cells are hæmolyzed when placed in fresh untreated serum obtained either from the patient or from a normal individual. Acid or carbon dioxide is added to the serum to counteract the alkalinity resulting from loss of CO_2 when the serum is exposed to

air. Normal corpuscles are not hæmolyzed by the patient's serum. It is an acquired disease.

Myoglobinuria is a rare disease in man, characterised by muscular atrophy and recurrent attacks of myoglobinuria. It is also met with in the crush syndrome. It occurs commonly in horses which are taken out to work after a rest. Myohæmoglobin derived from the muscles appears in the urine.

Spectroscopic examination of the urine reveals the presence and nature of the pigment. In paroxysmal hæmoglobinuria the patient is often a child or young adult suffering from congenital syphilis. The attack is excited by cold and may be induced by placing the extremities in cold water (Rosenbach test). There is a hæmolysin circulating in the blood, which at low temperatures attaches itself to the red cells and causes their lysis. This is the basis of the Donath-Landsteiner reaction. Granular casts may be found in the urine in exercise hæmoglobinuria.

Treatment. This varies with the cause. To avoid a mismatched blood transfusion adequate care must be taken in blood grouping. Cold hæmoglobinuria can often be cured by appropriate anti-syphilitic treatment. In other cases daily intravenous injections of ascorbic acid 300 mg., given for several days, have proved successful. The outlook in the nocturnal hæmolytic anæmic group is very grave. Repeated small blood transfusions should be given, and in no case should splenectomy be performed. Exercise or march hæmoglobinuria is a condition in which hæmoglobinuria appears after exercise in the erect position. It may be due to traumatic damage to red cells in the soles of the feet, and "Sorbo-rubber insoles" in the shoes may prevent its occurrence. It usually disappears without special treatment.

THE URINARY SYSTEM

porphyria. The urine may be of normal colour when passed, darkening on standing to a brown or red shade (port-wine colour). The pigment detected spectroscopically. Porphobilinogen, the chromogen precursor porphobilin, is detected in the urine by the Ehrlich aldehyde test. The red colour produced is distinguished from that resulting from the presence of urobilinogen, as the porphobilinogen is insoluble in chloroform and ether.

Pneumaturia

Gas may be passed with the urine when there is a fistula between the bladder and bowel, or an urethral fistula. Occasionally it is due to the presence of gas-forming organisms in the bladder.

Pyuria

Definition. Pus in the urine.

Etiology. The pus may come from the kidney, as in pyelonephritis, pyonephrosis, pyelitis, or renal calculus; from the ureter owing to the presence of a calculus; from the bladder in cystitis, new growth, a calculus, or an adherent and perforated diverticulitis or appendix abscess; and from the urethra in urethritis, or in periurethral suppuration such as may result from a prostatic abscess. The urine may be thick, or the pus may be present only in microscopical amounts. The best test for pus is the microscopical one of finding pus cells in the urinary deposit. The treatment is that of the various causative conditions.

Renal Function Tests

In medical cases, in addition to a general clinical examination, these tests are important for three varieties of problems:

1. Does proteinuria signify nephritis or permanent renal damage?
2. What is the type and severity of nephritis in any given case?
3. In cases of essential hypertension, is there failure of renal function?

The practitioner will require the following tests:

Examination of the Urine. The presence of protein, casts and cells. The determination of the relation of proteinuria to posture and exercise. The amount of urine passed by day and by night, and the specific gravity of the day and night specimens.

Examination of the Blood. An increase of urea and non-protein nitrogen is associated with acute glomerulonephritis and with malignant nephrosclerosis. A considerable increase renders the prognosis more unfavourable, suggesting the danger of uræmia.

The Excreting and Concentrating Power of the Kidney. This can be roughly determined by the urea concentration test and the water concentration and elimination tests.

The Blood Urea Clearance Test (Van Slyke). This shows the volume of blood, whose urea content is excreted in one minute's urine. With "standard clearance" the normal man excretes 1 ml. urine a minute, containing the urea content of 54 ml. of blood. The results can be

expressed as a percentage figure, *e.g.*, the kidneys are found to be 60% efficient. The normal figure is from 70% upwards.

The Water Concentration Test. This is performed as follows: The patient should have nothing to drink after lunch the day before the test. The evening meal should be dry and consist mainly of protein. The urine passed during the night is discarded. After emptying the bladder at 7 a.m. and discarding the specimen, the urine is collected at 8 a.m., 9 a.m., and 10 a.m. Normally the specific gravity of at least one specimen should be over 1.025.

The Water Elimination Test. The patient takes no food and no fluid after 8 p.m. The bladder is emptied at 7 a.m. and the specimen discarded; 1,250 ml. of water are then taken, and the urine is passed and measured at 8 a.m., 9 a.m., 10 a.m. and 11 a.m. The total of the four specimens should normally be over 80% of the fluid taken. The specific gravity of one specimen should be at least 1.003.

The Injection of Dyes and their Excretion. These tests are only applicable if there is no blood in the urine, and are chiefly of value in determining the separate function of each kidney, the urine being collected by ureteric catheters.

For practical clinical medicine the most simple and reliable tests are the examination of the urine for volume, specific gravity, protein, casts and cells, the blood chemistry, the blood urea clearance, and the urea concentration and water concentration and elimination tests. In normal cases the urine is more concentrated by night, the volume being less and the specific gravity being higher than in the day specimen. The urine also contains no protein, but a few hyaline casts and red corpuscles are of no significance.

The normal blood chemistry figures are shown on p. xix.

Percutaneous Renal Biopsy

In this procedure a small piece of kidney tissue, containing glomeruli and adjacent tubules, is removed by a special needle which is introduced through the skin and tissues of the loin under local anaesthesia. This operation is not devoid of the dangers of renal laceration, uncontrollable haemorrhage, and the spread of infection, and should only be carried out by experts in hospital. The portion of kidney removed is examined with the electron microscope.

The chief object of renal biopsy is to enable a correct diagnosis to be made, especially in the nephrotic syndrome and in persistent proteinuria. Thus in the former, uncomplicated amyloidosis or calcinosis may be discovered. The prognosis in nephrosis appears to be related to the degree of glomerular damage, and this may be shown by renal biopsy. It may also enable unsuspected inflammatory renal disease to be diagnosed and the causative organism to be isolated. It is of value in the diagnosis of systemic lupus erythematosus, subacute bacterial endocarditis, renal vein thrombosis and in following the course of renal disease. The state of the "healthy" kidney in unilateral renal disease may also be revealed by renal biopsy.

NEPHRITIS AND NEPHROSIS

(Bright's Disease)

Definition. Bright's disease includes inflammatory and degenerative changes of the kidneys. Suppurative renal lesions are excluded.

Varieties. The cause of the various types described is unknown, and it is difficult to classify them in accord with both clinical and pathological findings. The following is the classification adopted :—

Nephritis

1. Acute glomerulonephritis.
2. Focal nephritis.
3. Acute interstitial nephritis.
4. Acute pyelonephritis.
5. Subacute nephritis.
6. Chronic glomerulonephritis.
7. The kidney of pregnancy.
8. Chronic pyelonephritis.
9. Chronic phenacetin nephropathy.

Arteriolar Nephrosclerosis

Nephrosis

1. The nephrotic syndrome.
2. Amyloid nephrosis.
3. Chronic intercapillary glomerulosclerosis.

Acute Tubular Necrosis

* * *

Ellis, in 1942, proposed the following classification for Bright's disease :—

Nephritis.	{ Type 1 nephritis. Type 2 nephritis.
Essential hypertension.	{ Benign hypertension. Malignant hypertension.
Miscellaneous conditions.	{ Acute focal nephritis. Toxæmia of pregnancy. Mercurial nephrosis. Amyloid nephrosis. Chronic pyelonephritis. "Chronic nephritis" of lead workers.

Type 1 nephritis corresponds with acute glomerulonephritis. This has an abrupt onset. Type 2 nephritis has an insidious onset. The symptoms persist and recovery is unlikely. Ellis includes many cases of nephrosis in this group. Clinically it appears to correspond with cases

described as chronic nephritis with œdema or chronic hydræmic nephritis. The histological changes are said to differ in the two groups.

Acute Glomerulonephritis

(Type 1 Nephritis)

Definition. Inflammation and degeneration affecting the glomeruli and tubules of the kidney.

Etiology. Acute glomerulonephritis is secondary to infection in some site in the body. It is probably not directly due to organisms nor to their toxins, but to a substance formed during the immunising process to which the kidney is sensitive. The most common cause is the hæmolytic streptococcus associated with an upper respiratory tract infection, the nephritic symptoms appearing 7 to 21 days after the onset of the infection. It may be associated with tonsillitis, dental infection, inflammation of cervical lymph nodes, parotitis, and subacute bacterial endocarditis. The pneumococcus or streptococcus or streptococcus viridans may also be the causative organism. It is met with also in association with: Acute specific fevers, especially scarlet fever (third week) and less frequently measles, small-pox, and diphtheria. It may also occur in association with pregnancy and purpura. It rarely follows an operation for the removal of septic tonsils, a mastoid operation, or antrotomy. Certain chemical substances may produce a condition closely resembling acute glomerulonephritis. These include mercury, phosphorus, arsenic, cantharides, sulphonamides, carbon tetrachloride, etc. *Predisposing causes:* 1. Age: Children and young adults. 2. Sex: Males predominate. 3. Exposure to cold and alcohol which lower the resistance of the kidney.

Pathology. The kidney is normal in size or enlarged, and the capsule strips readily. In the early stages the kidney may be pale with ischæmic glomeruli, or mottled with the glomeruli seen as red points, or there may be increased vascularity, the cortex being swollen and blood readily exuding. Microscopically all the glomeruli are swollen and distended with shed endothelial cells, blood cells and thrombi. The tubules are affected after the initial glomerular changes, the cells showing cloudy swelling, and desquamation may occur. Blood and casts may be seen in the tubules. It is possible that the cutaneous capillaries are affected at the same time, accounting for the early appearance of the œdema. Glomerular lesions are characterised by oliguria, proteinuria and hæmaturia; tubular lesions by polyuria, the presence of casts and a low specific gravity urine.

Clinical Findings. Today acute nephritis is very rarely seen, indeed it is the exception to meet with any variety of nephritis in hospital. This may be due to the effect of sulphonamides or penicillin in rapidly cutting short an attack of tonsillitis. Clinically, the disease begins in three ways, conforming roughly to three types, a hæmorrhagic, an exudative, and a toxæmic or hypertensive type. It may thus begin with hæmaturia, micturition often being frequent and scanty; with œdema; or with toxæmic symptoms such as sore throat, dyspnoea,

headache, backache, limb pains, nausea, vomiting and diarrhoea, or convulsions (hypertensive encephalopathy). Several of these symptoms are often associated, and fever at the onset is common to each type.

On Examination: The patient looks slightly puffy or definitely swollen about the face; he is generally pale, and œdema may be present in the legs, over the lumbar region (lumbar pad), over the sternum and in the scrotum. The abdominal and thoracic wall may become œdematous and the swelling spread over the thighs. After the swelling has subsided, lineæ atrophicæ are sometimes observed. Ascites or pleural effusion may develop later. The swelling causes a feeling of stiffness, as if the body were in a leather case, and the patient often prefers to be propped up owing to a certain degree of dyspnoea. There is usually fever at the onset, with a temperature of 101° F. to 103° F. (38.3° C. to 39.4° C.), falling to normal in a week or 10 days. During the acute stage the blood pressure is generally raised for a few days, rarely above 160 or 180 mm. Hg. in an adult. Cardio-vascular system: There is generally no cardiac enlargement which can be detected clinically or radiographically, but the aortic second sound is often accentuated and a tic-tac rhythm may be noted. The pulse rate is increased. The lungs: A few scattered rhonchi or some basal râles are often heard. There are usually no retinal changes, but at times there are signs of hypertensive neuro-retinopathy, the arteries are narrowed, veins dilated, a few hæmorrhages are noticed or there may be slight œdema of the discs. The subcutaneous œdema fluid is rich in protein (over 1%). The urine: The volume is reduced to about 10 to 20 fl. oz. (300 to 600 ml.) or there may be anuria for a day or so. The specific gravity is raised (1.025 to 1.035). The colour is dark owing to blood and urates. Protein is present (0.4 to 2%). Microscopically: Hyaline, blood and epithelial casts, renal epithelial cells, and some red and white blood cells are seen, but the urine is usually sterile. The blood: Nitrogen retention often occurs during the acute stage. The protein and cholesterol contents are normal. The sedimentation rate of the red cells is raised. The urea concentration test should not be performed owing to the strain it places on the kidney. The water elimination test shows low values.

Differential Diagnosis. This usually presents little difficulty, the signs and symptoms being characteristic. Focal nephritis is excluded by the presence of œdema, the hypertension and the blood nitrogen retention. In some cases the disease is a reactivation of an old infection, when cardiac hypertrophy and arteriosclerosis may be expected. The presence of fatty casts in the urine is also suggestive of old-standing disease. Other causes of hæmaturia must be considered, but these are not usually associated with œdema, except in heart failure, where the cardiac condition is obvious. In Goodpasture's syndrome there is idiopathic pulmonary hæmosiderosis with hæmaturia (see pp. 179, 192).

Course and Complications. Acute nephritis is often a self-limited disease and about 80% of cases recover; after a few days the urinary output suddenly increases to about 60 to 80 fl. oz. (1.8 to 2.4 litres) a day, the amount of blood excreted diminishes, and the blood pressure

If there is evidence of an infective lesion in the throat or elsewhere a course of penicillin should be given. The treatment of convulsive (hypertensive) uræmia is described on p. 496.

Convalescence. The patient must be kept in bed until all blood and casts have disappeared from the urine, the œdema has gone, and the temperature and sedimentation rate of the red cells are normal. The associated anæmia is benefited by tab. Fersolate 8 gr. (0.2 G.), 2 t.i.d. p.c. The eradication of septic foci, especially in teeth and tonsils, is usually advised, but there is seldom evidence that tonsillectomy is of any value in curing nephritis or preventing it from progressing to a chronic stage.

Focal Nephritis

Definition. A condition characterised by hæmorrhages into certain glomeruli of the kidney.

Etiology. Focal nephritis is due to bacterial emboli, usually streptococcal. It occurs in association with such acute infections as tonsillitis, otitis media, erysipelas, puerperal fever, pneumonia, scarlet fever (during the first week), influenza, meningococcal meningitis, etc. In subacute bacterial endocarditis a condition of multiple glomerular embolisation often occurs.

Pathology. There is hæmorrhage into certain glomeruli, and there may be cloudy swelling of the epithelium of the tubules. In subacute bacterial endocarditis multiple infarcts occur in the glomerular vessels.

Clinical Findings. The patient is a child or an adult who, during the acute stage of one of the illnesses mentioned above, passes blood in the urine. The urine may be diminished in volume, containing blood, protein, and hyaline, granular, and blood casts. Streptococci can often be found in the urine. There is no œdema, no increase of blood pressure, and no nitrogen retention in the blood.

Differential Diagnosis. Focal nephritis is differentiated from acute diffuse glomerulonephritis by its onset during the acute stages of an infection, and the absence of œdema and hypertension.

Course and Complications. The urinary changes usually rapidly disappear, rarely proteinuria persists for some time.

Treatment. No special treatment is required for the renal lesion. If there is oliguria, the fluid intake should be restricted to 1 to 2 pints (600 to 1,200 ml.) until diuresis ensues. After recovery, focal sepsis in the tonsils or teeth should be treated.

Acute Interstitial Nephritis

Etiology. Acute interstitial nephritis occurred formerly in association with diphtheria, scarlet fever, septicæmia, and streptococcal tonsillitis. It is now rarely seen since the use of antibiotics.

Pathology. Areas of infiltration with red and white blood cells and plasma cells are seen in the cortex between the tubules and glomeruli.

Clinical Findings. It is impossible to diagnose this condition during

life. In some cases there is oliguria with slight noteinuria. Usually there is no hæmaturia, no œdema, and no hypertension.

Acute Pyelonephritis

Percutaneous kidney biopsy has shown that certain cases diagnosed as acute pyelitis have gross acute pyelonephritis involving the renal cortex, and probably the medulla. There is not necessarily any proteinuria. The condition is especially associated with pregnancy, and when bacilluria is discovered before childbirth it should be treated with sulphonamides, which in the majority of cases will prevent the occurrence of pyelonephritis. Acute pyelonephritis may also occur in infancy and early childhood.

Subacute Nephritis

Subacute nephritis may occur as a stage in the course of acute glomerulonephritis, the symptoms persisting for more than a few months from the onset. In other cases it may be an exacerbation of chronic glomerulonephritis.

Chronic Glomerulonephritis

Etiology. It is in this variety of nephritis that the greatest difficulty arises in classification. For clinical purposes we may recognise the type characterised by œdema (nephrotic nephritis), and that in which œdema is minimal, but in which there is hypertension and renal failure. In some patients the œdematous phase passes away before death occurs.

The Œdematous Type

Clinical Findings. In the early stages the clinical picture closely resembles either that of subacute nephritis or of chronic nephrosis. The characteristic features are the presence of œdema, rise of blood pressure, and retention of nitrogen in the blood. The urine is either normal in amount or slightly diminished. Sp. Gr. 1.020 to 1.026. Protein, 0.5 to 1%. Deposit; epithelial cells, a few red and white blood cells, and some hyaline and granular casts. The urea concentration and water elimination tests usually indicate deficient renal function. The œdema fluid is rich in protein, over 1%. In the nephrotic type the blood cholesterol may be raised and the plasma proteins diminished.

Differential Diagnosis. In some cases it is impossible to differentiate chronic glomerulonephritis from chronic nephrosis. The history of previous acute nephritis, a raised blood pressure, cardiac enlargement, retinal changes and the presence of more than a few red blood cells in the urine are characteristic of glomerulonephritis.

Course and Complications. The course is usually slowly progressive. Exacerbations, characterised by the presence of blood in the urine may occur. The patient may die from renal failure or from intercurrent disease, before a secondary contracted kidney develops. The œdema may increase, owing to the occurrence of nephrotic changes in the kidneys or of cardiac failure. Complications also include pericarditis, ulceration of the colon, and bronchopneumonia.

Prognosis. This is very unfavourable in cases which do not respond to treatment and in which the œdema does not disappear. It is also unfavourable if the disease progresses to the stage of secondary contracted kidney.

Treatment. The patient should be kept warm in bed during the œdematous stage. A salt-poor, moderate protein diet containing about 60 to 80 G., with a calorie value of about 2,200, should be given.

Moderate Protein Diet. Breakfast: Egg, 1; bread, 3 oz. (90 G.), or toast, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.); milk, 4 fl. oz. (120 ml.); marmalade or honey, $\frac{1}{2}$ oz. (15 G.); tea, 5 fl. oz. (150 ml.). Lunch: White fish (cooked), 3 oz. (90 G.); potato, 4 oz. (120 G.); green vegetables, 2 oz. (60 G.); stewed fruit, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.); bread, 3 oz. (90 G.), or toast, 2 oz. (60 G.). Tea: Bread, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.); jam, $\frac{1}{2}$ oz. (15 G.); milk, 2 fl. oz. (60 ml.); tea, 5 fl. oz. (150 ml.). Dinner: Chicken or lean meat (cooked), 3 oz. (90 G.); potato, 4 oz. (120 G.); green vegetables, 2 oz. (60 G.); fruit, 4 oz. (120 G.); bread, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.). Sugar for sweetening during day, 2 oz. (60 G.).

Bread made without salt should be used. No salt must be added in cooking or subsequently. The fluid intake should be restricted to about 85 fl. oz. (1,050 ml.), according to the urinary output.

Drainage of Fluid. The peritoneal or pleural cavity may be aspirated, or the legs drained by small incisions, which are kept covered with sterile gauze, while the patient sits up in a chair for 1 to 3 days. Corticosteroids should be given, as described for nephrosis (see p. 487). For the anæmia which is usually present transfusion of packed red cells may be given.

The Non-œdematous Type

Clinical Findings. The patient may complain of headache, dyspnoea, weakness, frequency of micturition especially at night, and symptoms of chronic uræmia, such as nausea, vomiting, or diarrhoea, and loss of weight.

On Examination: The urine: The volume is usually increased, relatively more being passed by night. Sp. Gr. 1.005 to 1.012. A trace of protein may be present. Deposit; a few epithelial and blood cells and an occasional hyaline or granular cast. The blood: The urea and non-protein nitrogen are raised, the cholesterol and protein normal. The heart: There is a tendency to hypertrophy of the left ventricle and the blood pressure is raised. The arteries are thickened. Ophthalmoscopic examination: Retinal hæmorrhages may be seen, with tortuous arteries passing over constricted veins.

In children the disease may occur insidiously and give rise to a condition of renal infantilism (also known as renal dwarfism or renal rickets), the growth being stunted, the bones deformed and the secondary sexual characteristics in abeyance.

Differential Diagnosis. It may be impossible to differentiate this condition from essential hypertension.

Course and Complications. The course is progressive with gradual

failure of renal function. Complications due to hypertension, such as convulsions or cerebral hæmorrhage, may occur.

Prognosis. This is very unfavourable. The patient usually dies from uræmia within 2 years of the appearance of retinal changes, or of a marked rise in the blood nitrogen, or death may be due to heart failure. Pregnancy affects the condition adversely and should be prevented or terminated.

Treatment. This is as described for nephrosclerosis (see p. 485).

The Kidney of Pregnancy

The kidney of pregnancy must be differentiated from an exacerbation of chronic nephritis, which, when present, usually shows itself during the first few months of pregnancy. The kidney of pregnancy resembles a nephrosis in that the renal changes consist in a degeneration of tubular epithelium. The cause is unknown. It is especially liable to develop in the second half of pregnancy, and in elderly primiparæ. It differs clinically from a typical nephrosis in that the blood pressure often rises considerably and convulsive attacks (eclampsia) are liable to occur. The renal function tests are usually normal, including the blood urea and non-protein nitrogen, and the urea concentration test.

Treatment. The patient should be admitted to hospital. A moderate protein low-salt diet is given. Chlorothiazide (see p. 243) is sometimes helpful as a diuretic. Sedatives should be given and if eclampsia develops it may be necessary to terminate pregnancy or induce labour. Ganglion blocking agents (see p. 286) must not be used to lower blood pressure owing to the risk of causing death of the fœtus.

Chronic Pyelonephritis

This is the most common renal lesion found at autopsy, but it is difficult to diagnose during life. The symptoms may be recurrent febrile attacks with aching in the loin, or of chronic renal failure with hypertension. The most important cause is recurrent bacterial infection which may be asymptomatic. The disease affects chiefly adolescents and young adults but it also occurs in infancy and childhood. The kidney lesions are focal. The urine may or may not contain protein, organisms, or white cells in excess.

Diagnosis is made by (1) Intravenous pyelography. This shows narrowing of the renal cortex, a small kidney, and dilatation and clubbing deformity of the calyces. Pyelonephritis may be present with a normal pyelogram. (2) Micturating cystography. The contrast medium is injected through a catheter into the bladder. In many cases a uretero-vesical reflux is shown on one or both sides. (3) Aortography. This may show areas of ischæmia in the kidneys. (4) Injection of a pyrogen (Pyrexal) results in a 100% increased excretion per hour of white cells in the urine if the urinary tract is infected. (5) Percutaneous biopsy may show the typical renal lesions if the needle strikes an affected spot in the kidney.

in which case cyclosterine, 250 mg. tab., should be given b.i.d. for 2 weeks, followed by 250 mg. on alternate evenings for several months. In cases of mixed infections monthly courses of sulphadimidine, tetracycline, ampicillin (Penbritin) and nitrofurantoin (Furadantin) may be given.

Chronic Phenacetin-Nephropathy

Interstitial renal fibrosis and papillary necrosis may occur in patients taking phenacetin for long periods. It may be mistaken for chronic pyelonephritis.

Arteriolar Nephrosclerosis

Etiology. Arteriolar nephrosclerosis is a complication of hypertensive vascular disease.

Pathology. The kidneys may be normal in size, slightly larger than normal, or somewhat contracted. Granulations are usually slight. The colour may be dappled by red and yellow areas. The changes in the arterioles are secondary to hypertension. There is hyaline degeneration beneath the endothelium of the arterioles which narrows their lumen, followed by atrophy of muscle fibres and replacement fibrosis. In addition to the changes in the arterioles and degeneration of the glomeruli and tubules, hæmorrhages may be seen.

Clinical Findings. The patient is usually an adult between the ages of 30 and 40, and more often a male. The condition may occur in children. The onset is often insidious, but in others it is sudden with a cerebral hæmorrhage or uræmic attacks.

On Examination: The heart is hypertrophied and the arteries thickened. The blood pressure is high, the systolic being usually over 200 mm. Hg., and the diastolic between 120 and 160 mm. Hg. In the "benign type" of the disease there is no evidence of renal failure and no renal retinopathy. Later, however, the malignant phase develops. Ophthalmoscopic examination: Hypertensive neuro-retinopathy is usually present. The disc is swollen, red, and its edges blurred. The retina shows fluffy white spots ("cotton wool" areas) due to exudate and fatty changes. Hæmorrhages are present. The arteries are narrowed ("silver-wire" appearance) and the veins dilated. The urine: The volume may be as much as 80 or 100 fl. oz. (2.4 or 3 litres), with an increase in the nocturnal output. In the later stages the excretion falls and a fixed amount tends to be passed every hour by day and night. Sp. Gr. 1.002 to 1.008. Protein, a trace to 0.5%. Deposit; occasional renal epithelial and red cells, and hyaline and granular casts. The blood: Urea and non-protein nitrogen are increased to 100 mg. per 100 ml. or more. Cholesterol normal. Creatinine may be raised to 2.5 mg. per 100 ml. Calcium may be low, 6 mg. per 100 ml. or less. The urea concentration and water elimination tests show low figures as the disease progresses.

Differential Diagnosis. The differentiation from chronic glomerulonephritis can only be made if the patient is seen in the early stages. The heart changes and high blood pressure precede the proteinuria and cylindruria in chronic glomerulonephritis.

Course and Complications. The course is slowly progressive; a cerebral hæmorrhage, uræmia, heart failure, and secondary infections such as bronchopneumonia are liable to occur. Terminal pericarditis and pleurisy are probably toxic in origin. Acute œdema of the lungs is rare, but attacks of nocturnal dyspnœa (renal asthma) with Cheyne-Stokes breathing may occur. Exacerbations of an acute nephritic type may also be noted, with œdema, increase of the protein, and the presence or more red cells in the urine.

Prognosis. This is always very grave, although the patient may live for several years. Unfavourable signs are a blood urea figure of over 200 mg. per 100 ml. and the presence of hypertensive retinopathy. In 90% of cases death occurs within 2 years of the diagnosis of the latter.

Treatment. The general regime consists in regular hours, moderation in work, exercise, diet, alcohol, and smoking. The two latter are best avoided completely. A mild dry climate during the winter is helpful, but if it is not possible to go abroad chills should be avoided. Diet: The protein allowed is determined to a certain degree by the blood nitrogen figures. The basal requirement is usually 1 G. protein per kg. body weight. With a blood urea of about 60 mg. per 100 ml. the patient can be put on the moderate protein diet (see p. 482).

With a blood nitrogen of over 100 mg. per 100 ml., a low protein diet, containing about 85 to 40 G. of protein, and a caloric value of 1,700 can be given for periods of 2 or 3 weeks, alternating with the moderate protein diet.

Low Protein Diet. Breakfast: Oatmeal (uncooked), 1 oz. (30 G.); bread, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.); milk, 4 fl. oz. (120 ml.); tea, 4 fl. oz. (120 ml.). Lunch: Green vegetables, 2 oz. (60 G.); potato, 4 oz. (120 G.); bread, 2 oz. (60 G.); butter, $\frac{1}{2}$ oz. (15 G.); stewed fruit, 2 oz. (60 G.); cream, $\frac{1}{2}$ oz. (15 G.); jam, $\frac{1}{2}$ oz. (15 G.); rice (uncooked), $\frac{1}{2}$ oz. (15 G.). Tea: Bread, 1 oz. (30 G.); butter, $\frac{1}{2}$ oz. (15 G.); tea, 4 fl. oz. (120 ml.); jam, $\frac{1}{2}$ oz. (15 G.); milk, 2 fl. oz. (60 ml.). Dinner: Vegetable soup; white fish or lean meat or chicken (cooked), 2 oz. (60 G.); potato, 4 oz. (120 G.); fruit, 4 oz. (120 G.); bread, 1 oz. (30 G.). Sugar for sweetening during the day, 2 oz. (60 G.).

The bowels should be kept acting freely with the help of salts, mag. sulph. 60 to 120 gr. (4 to 8 G.) in the morning. For insomnia chloral hydrate 5 gr. (0.3 G.) and sod. brom. 10 gr. (0.6 G.) may be given at night. For headache with high blood pressure tabella glyceryl. trinitrat. $\frac{1}{130}$ gr. (0.4 mg.) may be given 3 times a day, but it is not wise to endeavour to lower the blood pressure considerably. For dyspnœa due to acidosis alkalis such as sod. bicarb. 20 gr. (1.2 G.) may be given six-hourly, and if there is heart failure with œdema, digitalis should be given. The treatment of uræmia is considered later.

lium. The nephrotic syndrome includes many kidney conditions all of which are characterised clinically by (1) heavy proteinuria, (2) hypoalbuminaemia, (3) lipaemia with an increase in the blood cholesterol, (4) oedema of varying degree, and (5) the basal metabolic rate is often low.

Etiology. No cause is known for the lipid nephrosis. It is more common in children than in adults. The commonest condition giving rise to the nephrotic syndrome is glomerulonephritis. Thus, in a series of 98 cases in America, renal biopsies indicated that 46 were due to glomerulonephritis, 18 to systemic lupus erythematosus, 15 to diabetes mellitus, 11 to lipid nephrosis, 4 to increased renal vein pressure, 3 to amyloidosis and 1 to nephrosclerosis. Pyelonephritis occurred as a secondary lesion in 8 cases.

In addition to the above, poisons such as mercury ointment, or sensitivity to pollens, poison-ivy or bee-stings may provoke the nephrotic syndrome.

Pathology. It is believed that there is an increased glomerular permeability to proteins and lipids. The albumin molecule, and the smaller globulin ones, pass through rather than the larger globulin molecules. Nephrosis is not considered to be a primary lesion of the renal tubules. In lipid nephrosis changes are found by the aid of the electron microscope in the basement membrane of the glomerular capillaries which may be characteristic of the condition. No changes are found in other parts of the body. In the other varieties of the nephrotic syndrome changes characteristic of the condition may be found in the kidneys and elsewhere.

Clinical Findings. The patient is usually a child or young adult. The disease begins insidiously with languor, headache, pallor, swelling of the face, legs, scrotum or abdomen, and possibly nausea or diarrhoea.

On Examination : In severe cases there is anorexia, nausea, vomiting and diarrhoea. There is a fairly generalised oedema, and ascites and hydrothorax may also be present. The face is pale, but often there is no real anaemia and no cardio-vascular changes develop. The blood pressure is not raised. Retinal changes do not occur. The oedema fluid contains little protein, less than 0.1%. The basal metabolic rate is low. The urine : Volume 20 to 30 fl. oz. (600 to 900 ml.). Sp. Gr. 1.020 to 1.040. Acid (pH 5.4). Protein 1 to 6%, of which 50 to 80% is albumin. There may be a trace of sugar. Deposit ; leucocytes and epithelial cells, and occasionally a red cell. Hyaline, epithelial, granular and fatty casts, and doubly refractile lipid particles. Urea concentration test normal. Water elimination test shows low excretion. This is due to pre-renal deviation and not to failure of renal function. The blood : Protein about 4% (normal being 7.4%), of which 89% is globulin (normal being 37% globulin). There is retention of cholesterol (800 to 2,800 mg. per 100 ml., the normal being 140 to 280 mg. per 100 ml.), and lipaemia. The urea and non-protein nitrogen are normal.

Such a case as this conforms to the type described as lipid or "true" nephrosis, the renal changes being degenerative rather than inflammatory, and it is differentiated from the nephrotic type of chronic glomerulonephritis by the history and the tendency to hypertension in

the latter, and from amyloid nephrosis in which there are associated suppurative, syphilitic or tuberculous lesions.

Course and Complications. Complete recovery is said to be the rule in lipid nephrosis in children if proper treatment is given; but this is not always the case. The course is variable and death may result either from failure of renal function, with gradual increase of blood nitrogen and eventually uræmia, or from complications such as pneumococcal peritonitis and erysipelas. In adults the prognosis depends on the associated disease process, if any, but some cases recover after removal of a septic focus.

Treatment. The Wassermann reaction should be determined, and, if positive, a course of penicillin given (see p. 600). It is not now considered necessary to give the high protein diet recommended by Epstein. For an adult a diet may be given containing protein 100 to 180 G., carbohydrate 250 G. and fat 80 G. A child requires protein 2.8 G. per kg. bodyweight and enough fat and carbohydrate to yield a high caloric diet. Fluid should be restricted to 40 to 45 fl. oz. (1.2 to 1.3 litre). No salt must be used in cooking or added to the food.

Prednisone or prednisolone, should be given by mouth, beginning with 10 to 15 mg. (2 to 3 tablets) 6-hourly, with Gelusil 2 tablets 6-hourly. After 10 to 14 days the prednisone is reduced to 10 mg. 8-hourly, and after another 10 days to 10 mg. 12-hourly, and later to 5 mg. t.i.d. The amount of prednisone required is judged by the proteinuria. If the proteinuria increases more prednisone should be given. Potassium loss should be made good by giving tab. pot. chlorid. 0.5 G., 2 tabs. t.i.d., as determined by plasma potassium estimation. A weekly record should be kept of the patient's weight and blood pressure. This treatment may be continued for four days a week for months in suitable cases. If the proteinuria disappears the dosage of prednisone may be gradually lowered to zero. Steroid treatment is contraindicated if the blood pressure is considerably raised or if there is evidence of marked renal failure.

Hydrochlorothiazide should be given, 50 mg. tab., 1 or 2 tabs. daily with pot. chloride 0.5 G. tab., 1-2 daily. Later, spironolactone (Aldactone-A) 25 mg. tab., 1-4 daily may be given, reduced to 1 tab. daily. Penicillin may be required to ward off intercurrent infections and also for the treatment of syphilis in cases of syphilitic amyloidosis.

A preliminary venesection followed by a blood transfusion assists in restoring the blood proteins to their normal value.

Thyroidum may also be given, beginning with 1 gr. (60 mg.) t.d.s. and working up to large doses such as 15 to 40 gr. (1 to 2.4 G.) daily, as long as the blood cholesterol is raised. This is especially indicated in cases with a low metabolic rate.

when stained with iodine. Later, atrophy and fibrosis result in a small firm contracted kidney. Microscopically it is seen that amyloid is deposited around the capillaries and in the walls of the arterioles and venules. The glomerular vessels may be the only ones affected. Fatty and atrophic changes occur in the cells of the first convoluted tubules.

Clinical Findings. Edema develops, and the urine often contains a considerable amount of protein. There may be polyuria. The blood changes resemble those found in lipid nephrosis. The total protein may be as low as 4%, due chiefly to loss of albumin. The blood cholesterol is raised, 800 to 600 mg. per 100 ml. The nitrogen figures are normal, except in cases of amyloid contracted kidney in which there is azotemia.

Treatment. No special measures are indicated for the nephrosis, the underlying cause being the essential factor for treatment. Any septic focus should be removed. A sufficiency of protein should be given in the diet to compensate for the protein lost in the urine.

Chronic Inter-capillary Glomerulosclerosis

(Kimmelstiel-Wilson Kidney)

Pathology. There are probably two types of intercapillary glomerulosclerosis, a diffuse one with widespread thickening of Bowman's basement membrane, and a nodular, found in diabetes and called the Kimmelstiel-Wilson lesion, in which there are islands of hyaline material in the glomeruli. There is also thickening of Bowman's membrane to form a hyaline cap, and arteriolar sclerosis of the afferent and efferent glomerular arterioles.

Clinical Findings. The characteristic features are diabetes mellitus with heavy proteinuria, oedema, retinopathy, peripheral neuropathy and cardiac failure with hypertension. Elderly women are chiefly affected. Hypoproteinemia may occur in some cases.

Acute Tubular Necrosis

Definition. A condition characterised by acute degeneration affecting especially the ascending loops of Henle and the distal tubules.

Etiology. The lesions are due to various poisons or toxic substances, or to ischaemia. 1. *Bacterial toxins.* The so-called febrile albuminuria. The renal damage is usually slight. 2. *Chemical substances.* Mercury, bismuth, arsenic, phosphorus, carbolic acid, cantharides, sulphonamides and phenindione. 3. *Metabolic products.* Acidosis in diabetes mellitus. Metabolites which should be detoxicated by the liver have to be dealt with by the kidney when the liver function fails. This may occur in liver disease or after operations on the biliary tract. 4. *Hæmoglobinuria.* This may result from various causes such as a mismatched blood transfusion, paroxysmal hæmoglobinuria, blackwater fever, mushroom poisoning and the crush syndrome. 5. *Shock and low blood pressure.* These may be due to injury, hæmorrhage, concealed accidental hæmorrhage, an operation, abortion, coronary thrombosis, cholera, or high intestinal or pyloric obstruction.

Pathology. In severe cases there is a precipitation of casts in the ascending portions of the loops of Henle with tubular epithelial necrosis. The glomeruli may be swollen with an exudate in the intercapsular spaces. Cortical ischaemia may occur in the crush syndrome, due possibly to a reflex cortical vascular spasm.

Clinical Findings. The clinical findings are not those of the nephrotic syndrome. The characteristic feature of tubular necrosis is acute oliguric renal failure. This results in an altered water balance and a retention of metabolites. Potassium is liable to accumulate in the extracellular fluid which leads to muscular paralysis and cardiac failure. This is particularly common in the crush syndrome where potassium is liberated from the damaged muscles.

The Crush or Compression Syndrome

Etiology. This syndrome, which was described in Germany in the 1914-18 war, attracted attention in England as the result of injuries sustained in air raids in the 1939-45 war. It is liable to occur when a limb is crushed by fallen masonry, etc. Accidents in civil life, such as a fractured pelvis with central dislocation of the hip causing obstruction of the external iliac vessels, may result in the syndrome, without there being apparent muscle damage. It has also been described after a difficult labour.

Clinical Findings. The patient on admission to hospital may or may not be suffering from shock. In the former case he is pale, sweating and clammy, the blood pressure is low, the pulse feeble, and the Hb. % increased. The affected limb is swollen and oedematous; there may be areas of cutaneous erythema and vesicle formation. Pulsation may or may not be present in the peripheral arteries. The muscles feel firm, the power of moving the limb is restricted, and paraesthesia may be present. *Signs of renal failure are noted about the first or second day.* Early signs of failure are oliguria or even anuria, and the appearance of blood and protein in the urine. Brown casts of epithelial cells are present and the pigment is shown spectroscopically to be myohaemoglobin. The urinary urea and chloride figures fall, the blood urea and potassium rise, and the alkali reserve falls. The blood pressure tends to rise and remain above normal if the patient is transfused with serum or plasma. The terminal uraemic stages comprise vomiting, excessive thirst, coma, and death. When the serum potassium rises above 7 or 8 mEq./L (normal 4.4 to 5.6) the electrocardiogram shows changes. The T waves are tall and spiked, the QRS complexes are broad, the P wave is absent, and various arrhythmias develop. When the potassium figure reaches 8 to 12 mEq./L flaccid muscular pareses are liable to develop. It thus appears that both a rise and a fall in blood potassium result in muscular weakness, due perhaps to transference of potassium across the cell membrane.

Prognosis. Recovery, with complete restoration of renal function occurs in about one-third of the cases. The prognosis is better in cases due to medical and obstetrical causes than in those due to muscle injury

or surgical operation. The length of time that the limb has been compressed appears to bear no direct relationship to the prognosis. A fall in the blood urea is a favourable sign. In fatal cases death usually occurs between the fifth and eighth days.

Treatment. For anuria or oliguria a continuous intragastric drip is given, the fluid containing dextrose 400 G. and water to 1 litre. All vomit is collected, filtered through lint, and returned to the stomach through the drip. The total fluid given in 24 hours is 500 ml. plus the volume of urine passed in the previous 24 hours. Sodium and potassium are balanced quantitatively by daily observations on the serum contents. If vomiting is severe the fluid can be given through a plastic catheter introduced through the saphenous vein into the inferior vena cava. When the urine output exceeds 1 litre a day, a low protein diet is given instead of the drip feed. If the hæmoglobin is below 70% (10.4 G. Hb./100 ml.) a transfusion of packed red cells is given. The best way of dealing with the compressed limb is a matter of dispute. Some advise that a tourniquet should be applied as soon as the weight is removed from the limb, and that decompression should subsequently be slowly effected, when a good outflow of urine has been obtained. Others recommend that the limb should be packed in ice, or that incisions should be made to release the œdema fluid. Primary amputation of the limb with the idea of saving the kidneys has resulted in the loss of both life and limb. The alternative view, based on the theory that the blood has lost vital principles into the œdema fluid, is that the compression should be rapidly relieved, the limb bandaged from below upwards and intermittent pressure, up to 60 mm. Hg. applied over the œdematous limb, using a specially large sphygmomanometer cuff. The following are indications for hæmodialysis by the use of the "artificial kidney":—1. There is a good chance of restoration of renal function. 2. The patient is in a state of uræmic coma, or has intractable hiccough or vomiting due to renal failure. 3. The blood urea is over 400 mg./100 ml. 4. The plasma-bicarbonate figure is low (below 12 mEq./L), and the plasma-potassium is high (above 7.5 mEq./L). 5. The presence of intraventricular block as shown by electrocardiograms, and due to hyperkalæmia.

Other Causes of the Nephrotic Syndrome

These include thrombosis of the renal veins and poisoning with drugs such as troxidone (Tridione).

The Pathogenesis of Renal Œdema

Acute Glomerulonephritis. The œdema here cannot be due to protein loss in the urine. The plasma proteins are normal and the œdema fluid is rich in protein, 0.6 to 1%. The factors involved include oliguria due to glomerular damage, and increased reabsorption of sodium and water from the renal tubules. It is probable that the cutaneous capillaries are simultaneously damaged with those of the kidneys. A further factor is congestive heart failure with rise in the capillary blood pressure.

The Nephrotic Syndrome. The following factors are probably concerned with the production of œdema :—

1. *Hypoproteinæmia.* The colloid osmotic pressure is lowered by loss of protein in the urine, and hence fluid passes from the blood into the tissue spaces. The normal colloid osmotic pressure is between 40 and 50 cm. water, in nephrosis the figures vary between 5 and 20 cm. water. The protein lost from the plasma is albumin rather than globulin, owing to the smaller size of its molecule. The protein content of the plasma in nephrosis does not usually fall below 4 G. %. A further fall in the albumin figure is compensated by a rise in the globulin content. A second factor which may be partially responsible for the fall of the albumin content of the plasma is failure to synthesise new protein from amino-acids. The capillary permeability does not appear to be increased in nephrosis, as the œdema fluid and ascitic fluid protein content is low.

2. *Sodium Chloride Retention.* This is of great importance. It has been shown experimentally that if there is no sodium in the diet, the plasma proteins may be low without the production of œdema. It is not, however, believed to be the chief cause of œdema in nephrosis, and it is suggested that sodium chloride is retained in the body in nephrosis in order to maintain a nearly physiological amount of sodium chloride in the tissue fluids and plasma. If this is so the tubules must have the power, despite the disease of the kidney, of reabsorbing sodium chloride.

3. *Reduction in Plasma Volume.* Hypoalbuminæmia cannot be the only cause of œdema, because diuresis may occur in nephrosis without any rise in the albumin content of the plasma. This diuresis may be due to an increase in plasma volume.

URÆMIA

Definition. Toxæmia due to, or associated with failure of renal function.

Etiology. The cause is uncertain, and it probably differs in the various types of uræmia. A distinction may be drawn between prerenal, renal, and postrenal causes of uræmia.

Prerenal Causes. The primary changes occur in tissue metabolism, in the chemical composition of the blood, and in the circulation. There is probably secondary renal insufficiency, although no structural changes may be demonstrable in the kidneys. The causes may be listed as follows: Vomiting due to pyloric and intestinal obstruction, and hyperemesis gravidarum. Diarrhœa, especially infantile and that due to cholera. Hepatic disturbances, as after operations on the gall-bladder and bile-ducts, and cholæmia associated with acute hepatitis and cirrhosis. Diabetes mellitus with acidosis, especially in untreated cases. Addison's disease during a crisis. Severe hæmorrhage, particularly hæmatemesis. Post-operative and traumatic shock. Severe burns. Peripheral circulatory collapse, as in diphtheria and pneumonia. Coronary thrombosis associated with shock. Overdosage with alkalis

in the treatment of peptic ulcer. A mismatched blood transfusion and the crush syndrome.

Renal Causes. These include inflammatory, degenerative, and developmental changes in the kidneys, such as acute and chronic nephritis, bilateral renal suppuration, acute tubular necrosis, and congenital cystic disease.

Postrenal Causes. There is obstruction to the outflow of urine. This may be due to mechanical causes such as calculi blocking both ureters, a calculus obstructing the sole-functioning kidney, removal of the only existing or functioning kidney, accidental ligation of both ureters in a pelvic operation, pressure of a pelvic carcinoma on both ureters, or a vesical growth obstructing the orifices of both ureters. Incomplete obstruction may result from an enlarged prostate, a pelvic tumour, or a bilateral hydro- or pyonephrosis. Reflex inhibition of urinary secretion may be caused by a drainage tube placed in the bladder after prostatectomy.

Pathogenesis. There is always some retention of urea and other non-protein nitrogenous substances in uræmia. These are not considered to be the cause of the uræmic symptoms. There may be a high blood urea content without uræmia. The most important causes of uræmia are disturbances of electrolytic and water balance. The various factors which may be involved are :—

1. **Acidæmia.** Normally the kidney forms ammonia to neutralise acids which are excreted. Further, by the excretion of more acid sodium phosphate than alkaline sodium phosphate, acid excretion is increased. If the kidney fails to manufacture ammonia and to excrete phosphate and sulphate, acidæmia results. This may lead to a low blood bicarbonate figure, with clinical manifestations of acidosis, such as hyperpnoea.

2. **Alkalæmia.** This is uncommon in uræmia. It usually results from vomiting, but may be due to a high alkali intake. Alkalosis is characterised by headache, dislike of sweet foods, and tetany.

3. **Disturbance of Water Balance.** Polyuria with excessive sodium loss results in dehydration. The anorexia and vomiting, which are often present in uræmia, increase the dehydration.

4. **Hyperpotassæmia.** The potassium figure in the blood may rise to over 7 mEq./L (normal 4.45 to 5.6 mEq./L). This may result in sudden death from cardiac failure. The electrocardiogram shows the changes described on p. 489.

5. **Hypopotassæmia.** The characteristic features are flaccid paralysis. The electrocardiogram shows small, flat or inverted T waves, with prolongation of the Q-T interval.

6. **Hypocalcæmia.** The serum calcium is often low in uræmia. This may be due to increased phosphate in the blood. Twitchings or tetany may ensue.

In many of the conditions, such as hæmorrhage and shock, there is a fall in blood pressure which reduces the glomerular filtrate, and also renal anoxia which causes damage to the renal epithelium. In Addison's disease there is further an alteration in the electrolytic balance of the

blood and a rise in the hydrogen ion concentration. Excessive vomiting may produce azotæmia before alkalosis occurs, owing probably to loss of chlorides. In alkalosis due to excessive intake of alkalis, there is presumably some renal impairment. In a mismatched blood transfusion and in the crush syndrome renal failure results from blockage of tubules with epithelial and blood pigment *débris*, and from damage to tubular epithelium and cortical ischæmia.

Acute Uræmia

This is associated with certain types of acute hæmoglobinuric nephrosis, such as result from a mismatched blood transfusion or crush injuries to a limb. It is a true uræmia, there is azotæmia, and it is prerenal in origin. The uræmic symptoms quickly follow on the exciting cause, and the course of the syndrome, whether for better or for worse, is of short duration. Treatment may be given by intra-gastric drip of 1,000 to 500 ml. of 40% dextrose solution daily. If there is vomiting the dextrose solution may be injected through a polythene catheter into the saphenous vein or into a cubital vein. In some cases peritoneal dialysis has proved successful. Twice normal saline solution is given intraperitoneally by drip injection, the fluid being later drained off. The urea is eliminated into the peritoneal fluid. The "artificial kidney" is sometimes employed. Some promising results have been obtained in the treatment of acute oliguria due to hypotension associated with surgery, accidental trauma or an acute medical catastrophe, by the intravenous injection of 100 ml. 20% mannitol over 10 minutes, if the urine urea over blood urea ratio is less than 14.

Chronic Uræmia

Clinical Findings. It is usually known that the patient is suffering from chronic nephritis. The onset of uræmia is generally insidious, and the symptoms may be grouped under the headings of the gastro-intestinal, nervous, and respiratory systems. *Gastro-intestinal symptoms:* There is thirst, an unpleasant taste, which may be bitter or ammoniacal due to excess of urea and ammonia in the saliva, and loss of appetite. There may be nausea, vomiting, diarrhœa associated with uræmic ulceration of the colon, or constipation. *Nervous symptoms:* The patient may complain of general weakness, inability to concentrate, and insomnia. Persistent, dull headache is often an early symptom, in addition to which muscular twitchings may occur. Later, there may be hiccough, convulsions, amaurosis, and finally coma. *Respiratory symptoms:* Various types of dyspnœa are described, such as nocturnal attacks (renal asthma), Cheyne-Stokes breathing, or air hunger. The "hissing" breathing is not often heard and is usually produced in the nose. *Cardiac symptoms:* Cardiac failure and terminal pericarditis may occur. The skin is often dry, of a yellow tinge, and pruritus is troublesome. A skin "frost" (urea crystals) is rarely seen. Crystalline deposits on the skin may be due to sodium chloride. Some of the deposit should be scraped off the skin and treated on a glass slide with a

few drops of dilute nitric acid. After evaporation, if the "frost" is due to urea, crystals of urea nitrate will be seen. The temperature is usually subnormal and the patient is emaciated and dehydrated. The blood and cerebrospinal fluid show a rise in urea and non-protein nitrogen.

Differential Diagnosis. If the non-protein nitrogen of the blood is low in patients presenting the signs of chronic nephritis, it can usually be assumed that chronic uræmia is not present. Alkalosis can be confirmed by determining the alkali reserve of the blood.

Prognosis. This depends upon the cause, which sometimes can be removed, as in the case of an enlarged prostate. Some of the conditions, such as alkalosis due to overdosage with alkalis, respond rapidly to treatment (see p. 680). In others, such as malignant renal arteriosclerosis, the outlook is hopeless. Sudden death may occur in a patient who appears comparatively well.

Treatment. This must be directed primarily to the causative condition, and secondarily to the relief of symptoms and the restoration of the electrolytic and water balance as far as possible. Circulatory renal inefficiency, which is a factor in many cases of prerenal uræmia, must be treated, and postrenal obstruction removed. Most patients in a crisis of chronic renal failure are lacking in fluid.

The patient should be given a low protein diet (see p. 485) for 3 or 4 weeks, which can then be alternated with a moderate protein diet. A low protein diet is advisable because it is possible that certain of the protein metabolites are toxic. Further, it reduces the amount of urea which has to be excreted, and as urea causes osmotic diuresis this disturbs the water and electrolytic balance. Many protein substances also contain potassium which is a toxic substance in excess in uræmia.

Various remedies have been recommended for the nausea and vomiting, including chlorpromazine hydrochloride (Largactil) 25 mg. t.i.d., or 500 ml. of 1/6 molar sodium lactate solution intravenously. In severe vomiting nutrition can be maintained for several weeks by infusions through a polythene tube inserted into a cubital vein and passed into the superior vena cava. Dextrose, in strengths of 80% to 50%, can be transfused through this tube. Insomnia and headache may be relieved by pentobarbitone sodium (Nembutal) 1½ gr. (0.1 G.) capsule, once or twice daily. For hiccup inhalation of oxygen may be temporarily effective. Severe diarrhœa should be treated by the oral administration of streptomycin 1 G. b.i.d. Aperients should not be given owing to the risk of provoking uncontrollable diarrhœa. Anæmia requires transfusion of whole blood or of packed red cells.

Sodium chloride solution must be injected intravenously to compensate for extracellular dehydration. The amount of fluid required can be determined by estimation of the specific gravity of the plasma. For every 0.001 rise in the Sp. Gr. of the plasma above 1.027, 200 ml. of water are required. Sodium deficiency sometimes occurs without dehydration, and this results in cellular overhydration. The amount of sodium required is determined according to the information given in Chapter VI. For the maintenance of fluid balance a daily intake of

800 to 1,000 ml., plus a volume of fluid equal to the previous day's volume of urine, is given.

For the correction of acidosis sodium bicarbonate should be given by mouth, in doses of 2 to 6 G. or more, according to the plasma- HCO_3 level. Alternatively, isotonic sodium lactate can be administered intravenously.

For calcium deficiency an injection of 10 to 20 ml. of 5% calcium chloride solution should be given intravenously.

Hyperpotassæmia can be remedied by giving dextrose by mouth in doses up to 200 G. daily, covered by an injection of insulin. Hypopotassæmia requires the administration of potassium by mouth or intravenously (see p. 514).

In difficult cases an accurate estimation of the fluid and electrolytic intake and output, together with the level of the serum electrolytes, may be necessary for the correct adjustment of fluid and electrolytic administration.

Latent Uræmia

(*Urinæmia*)

This occurs when there is complete failure of renal function, and is due to postrenal mechanical causes (see p. 492). The symptoms are entirely due to retention of urinary substances, there is no element of dehydration or of hypertensive encephalopathy. Beyond anuria there may be no symptoms noted for the first 4 or 5 days. The patient then becomes a little drowsy, the temperature falls, and the pupils contract. The blood pressure does not rise. The blood urea and non-protein nitrogen figures are increased to over 200 mg. per 100 ml., and the alkali reserve falls to about 80 ml. $\text{CO}_2\%$. Vomiting and muscular twitchings may usher in the final stage of coma. Death usually occurs in from 10 to 14 days. Unless the obstruction, such as a calculus, can be removed, no treatment is available.

Acute Convulsive, Epileptiform or Eclamptic Uræmia

(*False Uræmia. Hypertensive Encephalopathy*)

Etiology. This is due either to acute glomerulonephritis or to hypertensive vascular disease.

Pathology. In acute glomerulonephritis there is probably cerebral œdema; in hypertensive vascular disease, cerebral vascular spasm.

Clinical Findings. The patient is usually suffering from acute glomerulonephritis, but acute symptoms may occur in association with chronic nephritis, or in cases of hypertension in which there is no nitrogen retention in the blood. It does not occur in association with nephrosis, as the blood pressure is not then raised. The blood pressure rises and the patient is suddenly seized with convulsions or becomes comatose. The convulsions may be local or general, and consist of a tonic and clonic stage, which may or may not be followed by coma. Amaurosis of one or both eyes may also occur. On ophthalmoscopic

examination spasm of the retinal vessels may be seen, or changes characteristic of hypertensive neuro-retinopathy (see p. 484). In some cases there is a prodromal stage, characterised by anorexia, headache, and paræsthesia (see also p. 285).

Course and Complications. The convulsions may rapidly cease, or prove fatal. In some cases there is an ensuing period of coma.

Differential Diagnosis. Coma and convulsions are symptoms of widely different pathological states. The diagnosis is usually established by the history of the case as regards renal disease, the exclusion of other signs of organic nervous diseases, and the examination of the urine, blood, cerebrospinal fluid, blood pressure, and discs. In lead encephalopathy, in addition to the convulsions, there is often retention of blood nitrogen, possibly due to renal vascular spasm.

Prognosis. This is always grave, but it is most favourable in cases of acute nephritis.

Treatment. The patient should be placed lying down, dentures removed, and care taken that an airway is maintained. If he can swallow, mag. sulph. 60 gr. (4 G.) in water is given by mouth and repeated in an hour. An intravenous injection of 40 ml. of 30% sodium chloride solution is then given, the patient being quietened during the injection by inhalations of chloroform, if necessary. If these measures fail, venesection or lumbar puncture may be performed, to lower the blood pressure and intracranial tension. If a lumbar puncture is made, the foot of the bed should be raised, as there is a danger of the medulla oblongata being impacted in the foramen magnum, and the fluid should be removed slowly. Further depletive measures include an enema at night, followed next morning by the rectal injection of 8 fl. oz. (240 ml.) of water containing 2 oz. (60 G.) of mag. sulph. (a 25% solution), run in slowly as for a colonic washout, and retained as long as possible, usually $\frac{1}{2}$ to 2 hours. The skin should be encouraged to act by a hot air bath, using an electric cradle and raising the temperature of the bed to 120° F. (48.8°C.) for 10 to 15 minutes. The bowels should subsequently be kept well opened daily with mag. sulph. 60 to 120 gr. (4 to 8 G.) mane, and plenty of fluids should be taken by mouth.

The Artificial Kidney

Toxic metabolites can be removed from the blood by dialysing it across an artificial membrane of cellophane in the form of tubing or sheets on the outside of which is a warm rinsing solution of suitable constitution, basically resembling that of normal plasma. The microscopic pores in the cellophane allow small molecules such as urea, phosphate, uric acid and sulphate to pass through and so be removed from the blood.

The blood is usually led through a cannula in the radial artery to the "artificial kidney," and is prevented from coagulation by heparin. It is returned to a vein in the forearm. The circulation is usually effected by a pump at a rate of 150–400 ml./min.

Hæmodialysis using the artificial kidney is of value in:—1. *Acute renal failure*, as in acute tubular necrosis. There may be acute potassium

poisoning, as shown by an electrocardiogram (see p. 489) in which case the potassium can be removed by dialysis. 2. *Chronic renal insufficiency* with chronic uræmia. It is not of value in hypertensive heart disease. 3. *Pre-operatively in chronic renal failure due to urinary obstruction.* 4. *Pre-terminal renal failure.* Patients may be kept alive and able to work for several years by dialysis of 10 to 16 hours twice a week using a special machine with indwelling Teflon catheters in a limb artery and vein. When not in action Silicone rubber tubes pass from the catheters through the skin to a Teflon bridge. When in use the bridge is disconnected, and the catheters are joined to the kidney machine. 5. *Acute poisoning*, due to salicylates, barbiturates, bromides, thiocyanate, and glutethimide (Doriden).

Hæmodialysis is contraindicated in cases of bleeding, because of the heparinization, and is only rarely required in acute glomerulonephritis.

Peritoneal Dialysis

Here 2 litres of a dialysing fluid are run through a cannula inserted through the abdominal wall into the pelvic peritoneum, and the fluid is run out about every 2 hours, using about 75 litres in 36 to 40 hours.

It is more painful than hæmodialysis, and there is a risk of infection owing to loss of protein. Urea and other metabolites dialyse into the fluid across the peritoneum. It is used in oliguric uræmia when the blood urea is not very high.

BACTERIAL INFECTIONS OF THE RENAL TRACT

Bacilluria

Definition. The presence of bacteria in the urine, not accompanied by local symptoms.

Etiology. The organisms may gain access to the urine from the blood, being excreted by the kidneys; from the intestines through the lymphatics in connection with the kidneys; or by an ascending infection of the urethra. Excretion of organisms by the kidneys implies a certain degree of renal damage. Such organisms as the *E. coli*, *Proteus vulgaris*, *Pseudomonas pyocyaneus*, *Salmonella typhi*, *Salmonella paratyphi*, A, B or C, *Mycobacterium tuberculosis*, streptococcus, staphylococcus, *Neisseria gonorrhææ* or the *Streptococcus pneumoniae* may be found. Chronic constipation is not a predisposing cause. In women habitual looseness of the bowels may be of etiological significance.

Clinical Findings. The history is of value. Thus the bacilluria may be a sequel of an acute illness, such as typhoid fever, or occur during an acute illness, such as pneumonia, bacterial endocarditis, or gonorrhæa. It may also be noted in cases whose chief symptom is debility, as in certain *E. coli* infections, or there may have been no symptoms attributable to the bacilluria.

Treatment. This depends upon the associated conditions, for which the special sections should be consulted.

E. coli Infections of the Urinary Tract

Pathology. The *E. coli* may gain access to the urinary tract by three routes: By the blood from the gall-bladder or intestine, by lymphatics from the intestine, or by ascending infections of the urethra to the bladder and thence by periureteral lymphatics to the renal pelvis. The lesions vary from slight degrees of cystitis and pyelitis to definite pus formation in the bladder or kidney.

Clinical Findings. The symptoms occur insidiously, or have an acute onset, and are met with in children or in adults, rather more frequently in women than in men. Cases of *E. coli* infection can be grouped clinically as follows: 1. *Children:* A cause of unexplained pyrexia and rigors. 2. *Women:* Before and after childbirth. 3. *Adults:* Cases fall into the following groups: (a) There may be no symptoms, *E. coli* being found in the urine on routine examination. (b) Acute renal or vesical symptoms, such as pain in the loin or in the hypogastrium, hæmaturia, frequent, painful and scanty micturition. (c) Acute abdominal symptoms. Acute pyelitis may be mistaken for appendicitis or salpingitis. (d) General constitutional symptoms. There is malaise and a continuous pyrexia. The condition is liable to be confused with other causes of obscure pyrexia. In children it may be mistaken for tuberculosis. (e) Chronic or recurrent renal or vesical symptoms. There may be aching in the loin or back, with frequency of micturition and feverish attacks. In most cases the whole of the urinary tract is involved, and micturating cystograms frequently show the presence of vesico-ureteral reflux.

The urine: This is acid and contains *E. coli*, a few pus cells and renal epithelial or vesical cells. With cystitis there may be larger quantities of pus. At the onset of pyelitis there may be a definite attack of hæmaturia. The odour of the urine is often "fishy" and the organisms impart to the urine a characteristic sheen. A trace of protein is usually present.

Differential Diagnosis. The diagnosis is established by the urinary examination; a mid-stream specimen should be taken. Catheterisation is dangerous, it may spread infection to the kidneys. In persistent cases X-ray examination and pyelography should be made to exclude the presence of calculus or other lesions.

Course and Complications. If untreated the organisms usually persist in the urine, and there is a danger of further infection occurring, such as pyelonephritis and pyonephrosis.

Prognosis. This is very favourable in cases which are recognised and treated early. If neglected it is more difficult to render the urine sterile.

Treatment. This is considered under the section dealing with pyelitis and cystitis (see below).

Pyelitis

Definition. Inflammation of the pelvis of the kidney.

Etiology. Pyelitis is usually due to infection with the *E. coli*, as

described above. Pyelitis may also be associated with a renal calculus, renal tuberculosis, obstruction of the ureters due to a calculus, abdominal tumour, or some anatomical abnormality, such as bifid pelvis, double ureter, nephroptosis, congenital hydronephrosis. It may be associated with cystitis, or urethral obstruction.

Varieties : Pyelitis may be acute or chronic.

Acute Pyelitis

Clinical Findings. The patient, who is suddenly taken ill, complains of malaise due to the fever and toxæmia. There may be no other symptoms, or he may complain of aching or tenderness in the loin with frequency of micturition. There may also be rigors.

On Examination : The temperature is found to be raised, and there is usually abdominal tenderness over the affected kidney. The urine shows the changes described above.

Differential Diagnosis. Acute pyelitis is liable to be mistaken for appendicitis, salpingitis, or, if occurring after childbirth, for puerperal septicæmia. The diagnosis is established by the examination of the urine.

Course and Complications. The course depends largely on the treatment given. Relapses are liable to occur or chronic pyelitis may supervene.

Prognosis. This is on the whole favourable.

Treatment. The patient should be put to bed and a saline purge given.

The Diet : The patient should take 6 to 8 pints (3·6 to 4·8 litres) of fluid daily, such as water, fruit juices and barley water. Hot applications such as cataplasma kaolini should be placed on the loin, if it is painful. The urine should be made alkaline by giving a mixture of Sod. bicarb. 30 gr. (2 G.), sod. cit. 30 gr. (2 G.), pot. acetat. 30 gr. (2 G.), syr. aurant. 30 m. (2 ml.), aquam ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) four-hourly. As soon as the urine is alkaline the temperature usually falls and the mixture can be given six-hourly and then 3 times a day as required. The sensitivity of the organisms should be determined. The majority of infections respond well to sulphonamides and antibiotics. The dose of sulphadimidine is four 0·5 G. tablets, followed by four tablets 4 hours later, and then two tablets t.i.d. for 7 to 14 days. The fluid intake should be about 4 to 5 pints (2·4 to 3 litres) in the 24 hours and a potassium citrate mixture given simultaneously. The dose of chloramphenicol for an adult is two 0·3 G. tablets eight-hourly for 5 to 7 days. Urolucosil (sulphmethizole), or Furadantin (nitrofurantoin), or mandelic acid may be indicated. The dose of Urolucosil is 0·1 G. tab., one or two tablets 5 times daily. The fluid intake should be restricted for 5 days to 2 pints (1·2 litre) daily, and no alkalis must be given. A maintenance dose of 1 to 3 tablets a day may be taken for 2 to 3 months. The dose of Furadantin for an adult weighing between 100 lbs. and 160 lbs. (45 kg. and 76·8 kg.) is 100 mg. (2 tablets) q.i.d., and if weighing over 160 lbs. (76·8 kg.), 150 mg. q.i.d. For a child the dose is 50 mg. Mandelic acid may be given as Mandelamine, four 0·25 G. tabs. t.i.d. for 2 weeks.

A potassium citrate mixture must not be given with Mandelamine as the pH of the urine must be kept between 5.5 and 6.5 and no restriction of fluid is required. Nalidixic acid (Negram) may be used in *E. coli* and *Proteus* infections. The dose is 2 tabs. (1 G.) q.i.d. for 14 days. Reactions may occur.

Chronic Pyelitis

(Relapsing or Quiescent Pyelitis)

Clinical Findings. Often there are no local symptoms, but the patient may complain of frequency of micturition and irregular attacks of fever with malaise.

Differential Diagnosis. This is established by ureteric catheterisation. An X-ray examination should be made to exclude a renal calculus, and the urine also examined for tubercle bacilli.

Treatment. It may be necessary to remove a calculus or relieve an obstruction by operation before a cure can be obtained. A course of sulphacetamide or of an antibiotic drug to which the organism is sensitive should be given as described above.

Cystitis

Definition. Inflammation of the bladder.

Etiology. Cystitis is due to infection with organisms such as the *E. coli*, the staphylococcus, the streptococcus, the *Neisseria gonorrhæa*, the *Mycobacterium tuberculosis*, and the *Salmonella typhi*. It may be associated with vesical bilharziasis, a calculus, adhesions between the bladder and colon or a diverticulum, a cystocele, pyelitis, enlargement of the prostate, an urethral stricture, pelvic tumour, retroverted gravid uterus, spinal medulla (cord) lesions, etc. **Predisposing causes:** Chill, constipation and over-indulgence in alcohol, and incomplete emptying of the bladder at micturition.

Clinical Findings. *Acute Cystitis.* The patient is suddenly taken ill with severe pain in the hypogastrium or perineum, and he has to pass urine every 3 or 4 minutes, only about a teaspoonful (4 ml.) being evacuated at a time. There is usually no fever and no constitutional disturbance. *Chronic Cystitis.* The symptoms are less marked, but there is often an aching pain over the pubes or in the perineum and frequency of micturition. The urine: An acid reaction implies infection with the *E. coli*, tubercle bacilli or gonococci. The urine is alkaline with the other infections and in any mixed infection. It is cloudy, contains a trace of protein, and blood may be present. The deposit shows vesical epithelial cells and often some pus cells. In children a staphylococcal infection is not uncommon. The parent notices that the urine is thick or contains slimy or stringy matter, which may only be present in the morning specimen.

Treatment. *Acute Cystitis.* The patient should be kept in bed and hot applications placed over the hypogastrium. The diet and regulation of the bowels are as for the treatment of pyelitis. If the urine is acid, an alkaline mixture should be given with tnc. hyosciami

30 m. (2 ml.) six-hourly. If it is alkaline, acid. sod. phosph. should be administered, such as Acid. sod. phosph. 30 to 60 gr. (2 to 4 G.), tnc. hyoscyam. 30 m. (2 ml.), sp. chlorof. 7 m. (0.45 ml.), aquam ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) in water six-hourly. A sulphonamide, Urolucosil, or Furadantin may be required, according to the sensitivity of the organisms. Surgical treatment may be required later to remove a causative condition.

Carcinoma of the Prostate

Temporary success attends the use of synthetic œstrogens. Stilbœstrol, hexœstrol, or dienœstrol may be prescribed. It is customary to begin treatment with stilbœstrol, in doses varying from 1 to 15 mg. a day, the larger amounts being given in divided doses three times daily. Subcapsular orchidectomy appears to increase the beneficial effect of stilbœstrol. The effect is judged by the patient's general condition and symptoms, and by the serum acid phosphatase content. In the untreated case the acid phosphatase is raised to between 10 and 80 King-Armstrong units or more, the normal figure being less than 2.5 units per 100 ml.

After a time, perhaps 2 to 4 years, the stilbœstrol may appear to lose its effect, or nausea and vomiting may be troublesome symptoms. The stilbœstrol may then be replaced by hexœstrol or dienœstrol in similar doses. The patient usually gains weight, loses his bone pains and prostatic symptoms, and there is enlargement of the breasts, the nipples becoming very tender with an overdose. In many cases, unfortunately, after relief of symptoms for a few years, the disease shows itself again and now fails to respond to treatment.

Pyonephrosis

Definition. Distension of the renal pelvis with pus.

Etiology. Pyonephrosis results from infection of the renal pelvis, together with obstruction to the outflow of urine. The latter may be due to a stricture, enlarged prostate, diverticulum of the bladder, vesical calculi, growth, etc.

Pathology. One or both kidneys may be affected, depending largely on the site of the obstruction.

Clinical Findings. The patient complains of malaise, and usually of aching or pain in the loins.

On Examination: A renal tumour may be felt on one or both sides. The temperature is usually raised. The urine contains pus, protein and organisms. If both kidneys are affected there is likely to be an increase in the blood urea and non-protein nitrogen.

Treatment. This is surgical.

Perinephric Abscess

Definition. Suppuration in the tissues around the kidney, usually in the pararenal fat.

Etiology. The infection may be blood-borne, the focus being in a cutaneous boil or carbuncle, or in the tonsils. Lymphatic spread may occur from an infected kidney, gall-bladder, appendix, or from spinal caries.

Clinical Findings. The patient may complain of no symptoms except malaise due to fever, and at times joint pains. In other cases an aching or a sharp pain may occur in the loin.

On Examination: The temperature is found to be raised and it runs an irregular intermittent course. Tenderness is elicited in the loin, and later a definite bulging may be seen, or a swelling is felt on abdominal palpation over the kidney. The patient may lie with the hip joint flexed on the affected side, if the abscess is tracking downwards. If, on the other hand, it is situated above the kidney, the diaphragm on the affected side may be raised. This results in some dullness and weak air entry over the base of the corresponding lung, but tactile fremitus is present. An X-ray examination will also reveal the position of the diaphragm. The blood: A leucocytosis of about 12,000 to 20,000 per c.mm. may be present. The urine contains a trace of protein, some pus cells and organisms (usually staphylococci) if the kidney is also affected. The abscess may eventually point in the lumbar triangle (Petit's triangle) or rupture intraperitoneally.

Differential Diagnosis. The history of a crop of boils or carbuncles is suggestive, but if there are no localising symptoms, other causes of obscure pyrexia have to be considered, and the diagnosis is not usually made until a swelling appears. In the early stages the persistent fever, joint pains and constipation are suggestive of bacterial endocarditis or of a *Brucella abortus* infection.

Treatment. This is surgical, the abscess being drained.

Treatment. Very successful results have been obtained by triple therapy, streptomycin 1 G. intramuscularly twice a week, isoniazid 100 mg. t.i.d. by mouth, and sodium para-aminosalicylic acid (P.A.S.) 5 G. t.i.d. by mouth. This should be continued for 1½ to 2 years. The patient should be in bed for 6 to 12 months. Surgical treatment is not usually required for urinary tuberculosis, but may be necessary in genital tuberculosis after a prolonged course of chemotherapy.

Tuberculous Cystitis

This is usually secondary to tuberculosis of the kidney, epididymis, or prostate. In vesical tuberculosis treatment on the above lines often has an extremely good result in increasing the capacity of the bladder and so in reducing the frequency of micturition.

Hydronephrosis

Definition. Dilatation of the renal calyces and pelvis.

Etiology. Hydronephrosis may be congenital or acquired, and is due usually to a gradual or intermittent obstruction to the outflow of urine.

Congenital Hydronephrosis. The obstruction may be caused by an abnormal branch of the renal artery, by a disordered function of the pelvi-ureteral junction, or by an imperforate urethra. It is usually bilateral.

Acquired Hydronephrosis. The causes may be grouped as follows :
1. Renal : A calculus or growth in the pelvis. 2. Ureteric : A disorder of the nervous control of the pelvi-ureteral junction. Kinking of the pelvi-ureteral junction by a movable kidney or renal tumour. A calculus or stricture. Pressure due to a pelvic or abdominal tumour, or adhesions. Injury during an operation. 3. Vesical : A calculus or tumour. 4. Urethral : A stricture, calculus, enlarged prostate or phimosis.

Pathology. The kidney substance atrophies and only a thin covering may remain. In internal hydronephrosis the calyces are dilated, but later the pelvis distends and the kidney substance may be replaced by a sac as large as a cocoa-nut, the ureter also dilating to the level of the obstruction. In intermittent hydronephrosis, which is usually associated with a kinking of the ureter, the pelvis dilates and contracts as the obstruction appears and disappears. Bilateral hydronephrosis is due to obstruction in the urethra or bladder.

Clinical Findings. *Intermittent Hydronephrosis.* The patient is usually a woman, who complains of periodical attacks of pain in the loin, generally on the right side, and nausea and vomiting, often associated with fever. There is scanty micturition and relief comes with the passage of large quantities of urine. The pain may be referred to the healthy side by a reno-renal reflex. Kinking of the ureter may give rise to pain resembling renal colic, which is known as a Dietl's crisis.

On Examination : A renal tumour may be felt which disappears with the onset of the polyuria.

Continuous Hydronephrosis. The symptoms are less marked, and

Etiology. The infection may be blood-borne, the focus being in a cutaneous boil or carbuncle, or in the tonsils. Lymphatic spread may occur from an infected kidney, gall-bladder, appendix, or from spinal caries.

Clinical Findings. The patient may complain of no symptoms except malaise due to fever, and at times joint pains. In other cases an aching or a sharp pain may occur in the loin.

On Examination : The temperature is found to be raised and it runs an irregular intermittent course. Tenderness is elicited in the loin, and later a definite bulging may be seen, or a swelling is felt on abdominal palpation over the kidney. The patient may lie with the hip joint flexed on the affected side, if the abscess is tracking downwards. If, on the other hand, it is situated above the kidney, the diaphragm on the affected side may be raised. This results in some dullness and weak air entry over the base of the corresponding lung, but tactile fremitus is present. An X-ray examination will also reveal the position of the diaphragm. The blood : A leucocytosis of about 12,000 to 20,000 per c.mm. may be present. The urine contains a trace of protein, some pus cells and organisms (usually staphylococci) if the kidney is also affected. The abscess may eventually point in the lumbar triangle (Petit's triangle) or rupture intraperitoneally.

Differential Diagnosis. The history of a crop of boils or carbuncles is suggestive, but if there are no localising symptoms, other causes of obscure pyrexia have to be considered, and the diagnosis is not usually made until a swelling appears. In the early stages the persistent fever, joint pains and constipation are suggestive of bacterial endocarditis or of a *Brucella abortus* infection.

Treatment. This is surgical, the abscess being drained.

Genito-urinary Tuberculosis

Tuberculosis may affect the kidneys, ureters, bladder, or the genital organs such as the epididymis, testes, seminal vesicles, prostate, uterine (Fallopian) tubes and, rarely, the uterus and ovaries.

Tuberculosis of the Kidney

Pathology. In the majority of cases the infection is blood-borne, ascending infection from the bladder being rare. The primary focus may be in the lungs, lymph nodes or elsewhere, but the site is often unrecognisable clinically.

Clinical Findings. The patient may complain of aching in the loin, frequency of micturition and blood in the urine.

Differential Diagnosis. If the urine contains tubercle bacilli and pus cells, renal tuberculosis is almost certainly present. Cystoscopy and catheterisation of the ureters are necessary to establish the site of the lesion. The presence of tubercle bacilli alone in the urine does not necessarily mean that progressive renal tuberculosis will inevitably ensue.

there is aching in the loin. If, however, the condition is bilateral and progressive, symptoms of chronic uræmia gradually ensue.

On Examination: A renal tumour may be felt. The blood: A rise in the nitrogen figures indicates that both kidneys are affected.

Differential Diagnosis. The hydronephrosis may be demonstrated by pyelography. If more than 20 ml. of 15% sodium iodide can be injected into the renal pelvis, hydronephrosis is held to be present. Radiography after intravenous injection of Uroselectan B may also demonstrate the lesion.

Course and Complications. The course must vary with the nature of the obstruction. Pyonephrosis may occur as a complication.

Prognosis. This also varies with the cause. Bilateral lesions prove fatal unless the obstruction is removed before irreparable and extensive renal damage has been done, death occurring from uræmia or suppuration.

Treatment. If the hydronephrosis is due to a movable kidney a renal support should be tried. If this does not afford relief an operation will probably be necessary. In the majority of cases the treatment is surgical.

Nephrolithiasis

(Renal Calculus)

Etiology. The cause of calculus formation is not known. Certain factors undoubtedly play an important part. These include infection, urinary stasis, a concentrated urine, and the presence of irreversible colloids, such as fibrin, which after precipitation will not go back into solution. Overdosage with alkalis, as in the treatment of peptic ulcer, may lead to the formation of phosphatic calculi. It is not known whether calculi are associated with a deficiency of vegetables in the diet, and it is uncertain why they are prone to occur in England in certain localities, as in Norfolk. In India, stone occurs amongst the poorer members of the community who live chiefly on cereals and do not have sufficient milk. This is possibly due to lack of vitamin A. They are not believed to be associated with chalky water. Owing to decalcification of bones calcium phosphate calculi may form in hyperparathyroidism or more rarely in hyperthyroidism. They may occur without any bony lesion. Lying in bed for a long time, in the treatment, for example, of a fractured femur or poliomyelitis, or trauma to the kidney, is responsible for calculus formation in some cases. Sulphonamides may also result in renal calculus formation if sufficient fluid is not taken during their administration. The acetylated form of the sulphonamide is precipitated in the kidney. Continued over-dosage with vitamin D may also lead to the formation of renal calculi. Calculus formation usually occurs after the age of 20, males being most often affected, but urates may be deposited in the kidneys of infants, and vesical calculi found in the bladders of poorly-nourished children. Occasionally a large calculus is found in the kidney of a child under the age of 2 years. One composed of sodium, magnesium and ammonium phosphate, and another of xanthine, have been removed. Cystinuria

is an hereditary disease of the amino-acid transport, occurring in the proximal renal tubules.

Pathology. Calculi usually form around a colloid nucleus, such as fibrin, mucopus, cell debris and micro-organisms. Primary calculi are said to form in acid urine without any bacterial inflammation, whereas secondary calculi are deposited in alkaline urine infected with organisms. Thus a phosphatic crust may be formed around an uric acid nucleus. The following varieties are described: *Uric acid*: Brown, hard and irregular. *Calcium oxalate* (mulberry calculus): Dark and irregular. When formed in the bladder they are round, they may be dendritic when occurring in the renal pelvis. They are often mixed with calcium phosphate or uric acid. *Ammonium urate*: Hard and brownish. *Triple-phosphate*: Rather soft and smooth. *Mixed or laminated calculi*: They have an uric acid nucleus and a phosphatic coating. *Cystine*: Soft yellow-green, radially laminated. *Xanthine*: Reddish brown. *Indigo*: Blue, will mark paper. It is derived from indol and is extremely rare. *Calcium carbonate*: Smooth, hard and dark grey. *Urostealith*: Containing cholesterin.

Clinical Findings. If the calculus remains in the kidney substance there may be no symptoms, or the patient complains of aching in the loin, and protein and blood are found in the urine. These symptoms may be related to jolting. If the calculus obstructs the outflow of urine there is severe pain owing to stretching of the renal capsule. This may occur with a stone in the ureter, and the pain is due to this distension rather than to the passage of the stone along the ureter. The pain ceases either when the kidney does not secrete more urine, or when the obstruction is relieved. The pain is felt in the flank and may be referred to the sound side, it may also radiate to the groin and inner side of the thigh. There is usually a sense of nausea, and vomiting may occur. Renal colic is an agonising pain, which is probably caused by muscular spasm of the renal pelvis and ureter. The pain occurs in paroxysms and radiates along the course of the ureter to the groin, hypogastrium and testicle, and the testicle may be drawn up. The patient is pale or flushed, sweats, rolls about in agony and may vomit. There is a frequent desire to micturate, and the urine is scanty and may contain blood. The attack lasts usually from a few minutes to 2 hours, but it may be considerably longer. After the attack there is aching and tenderness in the loin.

On Examination: During the attack there is abdominal rigidity on the affected side. The chief symptoms of a vesical calculus are attacks of pain felt at the end of the penis after micturition, radiating to the perineum and inner side of the thigh. There is also frequency of micturition and the urine shows evidence of cystitis.

Differential Diagnosis. Renal colic must be differentiated from other varieties of abdominal colic and pain, such as biliary, intestinal, appendicular or pancreatic colic, or from a Dietl's crisis associated with a movable kidney and kinking of the ureter, from a twisted ovarian cyst, or rarely from a tabetic crisis. The X-rays will show renal calculi, provided they contain a sufficiency of calcium (see Fig. 46). Other

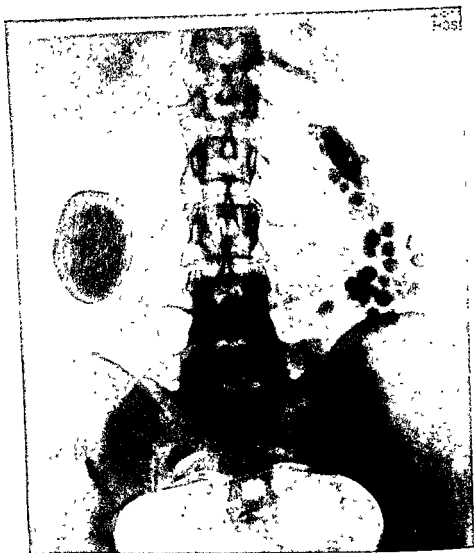


FIG. 46. MULTIPLE RENAL CALCULI.

generally affected. The patient may complain of aching in the loin, or of attacks of severe pain in the loin radiating along the course of the ureter to the groin or inner side of the thigh (Dietl's crisis). Micturition is scanty and there may be hæmaturia. This is probably due to kinking of the ureter. An intermittent hydronephrosis may develop. In some cases relief is obtained by wearing a belt with a kidney pad, but operation may be necessary in cases of Dietl's crises.

Congestion of the Kidneys

Passive congestion occurs in heart failure (cardiac kidney) or is due to obstruction of the renal veins. The urine is diminished in volume, the specific gravity is raised, protein is present and red cells, granular and hyaline casts may be found in the deposit.

Infarction of the Kidneys

The emboli are usually derived from the heart. Minute bacterial emboli, in subacute bacterial endocarditis, give rise to focal nephritis. Larger infarcts cause severe pain in the kidney region with hæmaturia.

Syphilis of the Kidneys

Chronic nephrosis may occur in the secondary stage. Later, gummata may form, with an associated amyloid degeneration of the kidneys.

Renal Tumours

Simple Tumours. These are comparatively rare. They include a fibroma, adenoma, lipoma, papilloma and angioma. An angioma of the renal pelvis may give rise to severe and so-called "essential" hæmaturia. A papilloma of the pelvis tends to be locally malignant, recurring after removal and spreading down the ureter.

Malignant Tumours. These may be primary, and include a carcinoma, such as an adenocarcinoma (hypernephroma or Grawitz tumour). A squamous epithelioma may form in the renal pelvis. The primary sarcoma includes an embryoma (Wilms' tumour, containing muscle fibres and rarely cartilage and bone). Secondary carcinoma and secondary melanotic sarcoma also occur.

Pathology. The hypernephroma. This is now usually considered to be a papillary adenocarcinoma arising in the renal tubules. It may occur in any part of the kidney. It shows yellowish fatty areas, and hæmorrhages or cysts may be present. Secondary deposits form in the long bones, such as the tibia, in the bodies of the vertebræ, and in other organs, such as the lungs, liver and brain. The bony deposits are often very vascular. Other varieties of carcinoma include an alveolar adenocarcinoma and a tubular adenocarcinoma.

Clinical Findings. The patient may be an infant, in which case the tumour is usually a sarcoma or hypernephroma.

On Examination: The child is weak, pale, wasted and the abdomen is swollen. A renal tumour may be present. The characteristic signs of

shadows such as those caused by calcified lymph nodes and phleboliths must be excluded. Pyelography may thus be required in order to localise the shadow accurately.

Course and Complications. Several attacks of renal colic are not infrequent. The chief complications are due to : 1. *Infection*, resulting in pyelitis, pyelonephritis, pyonephrosis and cystitis. 2. *Obstruction*, producing hydronephrosis, pyonephrosis, renal atrophy and anuria if both kidneys are put out of action. 3. *Ulceration*, with extravasation of urine through the ureter. A stricture may subsequently form. 4. *Malignant disease*, affecting the kidney.

Prognosis. In some cases only one attack of renal colic occurs, but the prognosis is always serious, as the calculi tend to recur even after operative removal. The stone may be passed without an operation. If both kidneys are affected, or if there is evidence of failure of renal function, the outlook is very grave.

Treatment. Prophylactic. Plenty of fluids should be drunk in hot climates. Pyelitis should be adequately treated.

Curative. During the attack : Local heat applied to the loin or a hot bath may relieve the pain of a mild attack. For a severe attack an injection should be given of morphin. sulph. $1/3$ gr. (20 mg.) and atropin. sulph. $1/100$ gr. (0.6 mg.). **After the attack :** To aid the passage of the calculus along the ureter, a mixture containing tnc. belladon. 15 m. (1 ml.) and pot. citras 80 gr. (2 G.) should be given every 6 hours until the pupils dilate. If the stone is not passed, the opinion of a surgeon should be obtained as to the advisability of operative removal. In any case the patient should be kept in bed until the hæmaturia has ceased, and an alkaline mixture given, if the urine is acid, containing Pot. cit. 80 gr. (2 G.), pot. bicarb. 20 gr. (1.2 G.), sod. bicarb. 20 gr. (1.2 G.) sp. chlorof. 7 m. (0.45 ml.), aquam ad 1 fl. oz. (30 ml.). 1 fl. oz. (30 ml.) t.d.s.

Subsequent treatment : If oxalate or urate crystals are present in the urine, a dose of the alkaline mixture should be given at night, sufficient to render the morning specimen of urine alkaline. The diet should be rich in vegetables, and if urates are passed meat should only be taken in small quantities, and substances rich in nucleo-protein, such as sweetbreads, kidneys and liver, should be avoided. The diet recommended for oxaluria is described on p. 471. In all cases, at least 4 to 5 pints (2.4 to 3 litres) of bland fluids should be taken in the 24 hours. Drinking a pint of fluid every 6 hours by day and by night appears to dissolve cystine calculi and to prevent their formation. D-Penicillamine, 150 mg. caps., 3 caps. q.i.d., together with pyridoxine 50 mg. q.i.d., may dissolve the stones if given for 3 or 4 months. If there is fever or a rash desensitization may be effected by stopping the penicillamine and then beginning again with small doses.

Movable Kidney

(Floating Kidney. Nephroptosis)

Undue mobility of the kidney is not of great clinical importance. Three degrees are described, palpable, movable and floating. The patient is usually a middle-aged woman and the right kidney is

The kidney substance may be almost entirely replaced by cysts. They contain a clear or turbid fluid, in which urea and blood may be present. One or both kidneys may be affected. In addition, cysts may be found in the liver and pancreas and at times in the lungs.

Clinical Findings. The infant may be still-born, or may die rapidly from uræmia. If occurring in adults no symptoms are usually noted until after the age of 30. The symptoms are then those of malignant renal sclerosis or of a renal tumour. The patient complains of lassitude, headaches, attacks of nausea and vomiting, or of an aching in the loin.

On Examination : An irregular renal tumour may be felt on one or both sides. The heart is usually enlarged, the arteries thickened and blood pressure raised. The urine resembles that of nephrosclerosis, the volume being increased, the specific gravity low, and a trace of protein being found, with an occasional hyaline or granular cast. Periodical attacks of hæmaturia may occur. As the lesion progresses, the blood shows retention of urea and non-protein nitrogen.

Differential Diagnosis. The diagnosis cannot usually be established unless the irregular knobbly kidney is palpable. Retrograde pyelography shows characteristically lengthening and compression deformity of the pelvis and calyces, of the "dragon" or "spider" type. The calyces and pelvis may show clear-cut crescentic indentations, sometimes with a half shadow due to projection of the cyst into the calyx or pelvis. These changes are bilateral. An operation may be performed for a renal tumour, and the true nature of the lesion may only be discovered in this way.

Course and Complications. The course is progressive, with gradual failure of renal function. Polycystic degeneration of the liver and pancreas follows in some cases. Cerebral hæmorrhage may occur as a complication, which may be due to rupture of an aneurysm of the *circulus arteriosus* (of Willis).

Prognosis. Death may ensue in from 3 to 25 years after congenital cystic disease has been diagnosed. The patient may live for many years with a high blood nitrogen content.

Treatment. This is as for arteriolar nephrosclerosis. The kidney should not be removed by operation.

The Solitary Cyst

This is usually met with in children. It is probably a variety of polycystic disease. The cyst is generally situated in the renal cortex, and may contain over 2 pints (1.2 litre) of fluid. In adults large solitary serous cysts occur in the parenchyma of the kidney. They contain clear yellow fluid.

Retention Cysts

These are met with post-mortem in cases of chronic nephritis. Clinically they give rise to no symptoms.

this are : A tumour is felt in the loin, which enlarges downwards and backwards, and later extends towards the mid-line. It is dull on percussion, the dullness extending backwards to the flank. A band of colonic resonance may be found running across it. The tumour has a rounded border and the upper pole may be palpable. There is very slight movement with respiration. The urine may contain blood or protein.

In an adult a hypernephroma may be so small that it gives rise to no local signs, or it may form a definite swelling. Pyelograms may reveal that one kidney is abnormal. An aortogram may reveal the presence of a renal tumour with masses of tortuous arteries. Painless hæmaturia is the earliest sign of a renal tumour in the majority of cases. In the male the presence of a varicocele, occurring for the first time in a patient of middle age, which does not disappear on lying down, is very suggestive of a malignant renal tumour, especially if it is right-sided. Fever may occur apart from evidence of infection, with an increased sedimentation rate of the red cells. Secondary deposits are likely to form in the bones, especially in the skull, vertebræ, femur and humerus. Secondary deposits in the lungs usually give rise to no symptoms, but X-ray examination reveals the presence of soft woolly shadows in both lung fields.

If blood is present in the urine, catheterisation of the ureters will show from which kidney it is coming.

Prognosis. Death usually occurs from 1 to 2 years from the date of diagnosis.

Treatment. The results of nephrectomy or of X-ray treatment are disappointing.

Renal Cysts

The following varieties of cysts may occur in the kidneys : Congenital cystic kidney. Solitary cysts. Retention cysts. Hydatid cysts. Degeneration cysts in new growths.

Congenital Cystic Disease of the Kidneys

(Polycystic Disease)

Etiology. There are two types of the disease, infantile and adult. In both the cysts are glomerular and appear as closed systems. In the infantile type there is no morphological evidence of a connection between the cysts and the renal pelvis. In the adult type cysts appearing along the course of the tubules as a rule are connected with the excreting tubules and renal pelvis. The etiology is obscure. In the infantile type the theory that there is a failure of the tubule of the nephron to unite with the collecting tubule may hold good, but this is not so in the adult type. The cystic nephron of the adult retains part of its functional activity and takes part in the formation of urine. This would explain why the adult with the disease may survive until late middle life.

Pathology. The kidney may be considerably enlarged, so much so that when occurring in the foetus it causes difficulty in labour.

CHAPTER VI

FLUID AND ELECTROLYTE BALANCE

Disturbances of water and electrolyte metabolism may produce serious and irreversible illness. It is important, therefore, to understand the basic principles of fluid and electrolyte physiology, so that these disorders may be recognised, corrected, and, if possible, prevented.

Basic Physiological Considerations

The total body water is estimated as 50 to 65% of the body weight, the greater the fat content of the body the smaller the proportion of water. Thus the total body water of a man weighing 11 stones (70 kg.) is approximately 45 litres, made up as follows:—

Intracellular fluid . . .	30 to 35 litres	
Extracellular fluid . . .	12 litres	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> Tissue fluid 9 litres Blood plasma 3 litres </div> </div>

Normal Daily Fluid Balance. The normal healthy adult on a normal diet in a temperate climate has the following water balance:—

<i>Intake (ml.)</i>	<i>Output (ml.)</i>
Fluid by mouth . . . 1,200	Urine 1,200
Water content of food. 1,000	Invisible loss (lungs and
Water of oxidation . . 800	skin) 1,200
	Stools 100
2,500	2,500

Thus the fluid intake in such a person should equal approximately the urine output. This does not usually apply in other circumstances; for instance, in febrile patients and in hot climates the invisible loss may be much greater.

Normal Electrolyte Balance. The blood plasma normally has an equal amount of acid and base, each adding up to a total of 155 milli-equivalents per litre (mEq./L.). The milli-equivalent per litre is obtained by dividing the figure in mg. per litre by the atomic weight of the ion concerned, and multiplying this figure by the valency. Below is given a list of the common ions, together with their conversion figures:—

Na ⁺	mg. per 100 ml. × 10 divided by 23
K ⁺	" " × " " 39
Ca ⁺⁺	(" " × " " 40) × 2 (valency)
Mg ⁺⁺	(" " × " " 24) × 2
Cl ⁻	" " × " " 35
HPO ₄ ⁻	" " × " " 31) × 1.8
SO ₄ ⁻	(" " × " " 32) × 2
Alkali reserve : CO ₂ vols. per 100 ml. divided by 2.22.	
Plasma protein : G. per 100 ml. × 2.45.	

Hydatid Cyst

This is due to an echinococcus infection. If the cyst ruptures into the renal pelvis, there is renal colic, and hooklets are found in the urine. It may also burst into the intestine or peritoneal cavity.

Cystic Degeneration of a New Growth

This is only discovered at the autopsy.

Fusion of the Kidneys

This usually occurs at the lower poles, constituting the "horse-shoe" kidney. Less often fusion of the upper poles is present, or the upper pole of one kidney unites with the lower pole of the other, or both kidneys fuse to form the "cake" kidney.

may upset this considerably. Impairment of concentrating power of the kidneys leads to larger amounts of obligatory urine than normal, in order to excrete a given amount of waste products. This in turn alters electrolyte excretion in the urine.

Types of Disturbances

These may take the form of excessive intake, deficient intake, excessive loss, diminished loss, or a mixture, *e.g.*, in pyloric stenosis there is both excessive loss and diminished intake.

Three of the common types of upset of electrolytic balance are illustrated in the diagram (see Fig. 48). Gastric juice usually contains

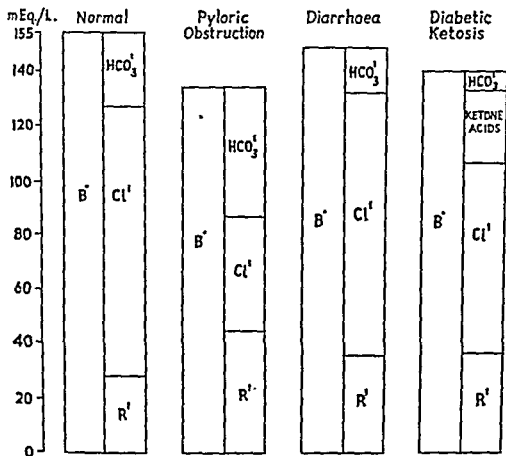


FIG. 48. ACID-BASE COMPOSITION OF BLOOD PLASMA IN VARIOUS CONDITIONS. B represents total base. R represents sulphate and phosphate radicals, organic acids and plasma proteins. (After Gamble, James L.)

free HCl, and hence in any condition where there is vomiting, more Cl' will be lost than Na. In pyloric obstruction, therefore, in addition to loss of base due to dehydration and increase in R (due to increased concentration of plasma proteins because of reduction of plasma volume resulting from dehydration, and retention of phosphates, and sulphates) the total mEq./L. will be less than 155. More Cl' is lost than base Na and this is compensated for by an increase in HCO₃ compartment. The end result, therefore, is water deficiency, diminution of base, hypochloremia and alkalosis.

Thus to convert a normal serum calcium level of 10 mg. per 100 ml. to mEq./L. : $\frac{10 \times 10}{40} \times 2 = 5$.

The acid-base composition of normal plasma is as follows (see also Fig. 47) :—

Base mEq./L.		Acid mEq./L.	
Na	142	HCO ₃	27
K	5	Cl	103
Ca	5	HPO ₄	2
Mg	3	SO ₄	1
		Organic acids	6
		Plasma protein	16
	<u>155</u>		<u>155</u>

The type of diagram (see Fig. 47) introduced by Gamble, forms a convenient basis for working out electrolytic problems. The acid and base columns must always add up to the same total figure. If this is less than 155 mEq./L. the plasma is hypotonic, as occurs when the loss of electrolytes is excessive and insufficiently replaced. A total greater than 155 mEq./L. is rare, and occurs in such conditions as alkali alkalosis, in the absence of much vomiting.

The daily requirement of Na as NaCl in health is 2 to 5 G. (35 to 85 mEq.), most of this being excreted in the urine as excess, there being an obligatory loss in the sweat only of 10 to 20 mEq. Similarly, there is only a small (10 mEq.) obligatory loss of potassium, in the sweat and faeces, so that a daily intake of 2 to 4 G. (51 to 102 mEq.) in health is ample, the excess again being excreted in the urine. In cases of diarrhoea, however, much Na and K may be lost in the stools. Most of the exchangeable sodium in the body is in the extracellular fluid, whereas potassium is largely an intracellular ion.

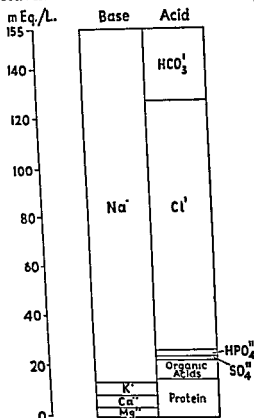


FIG. 47. ACID-BASE COMPOSITION OF BLOOD PLASMA. (After Gamble, James L. "Chemical Anatomy, Physiology and Pathology of Extracellular Fluid," sixth edition, Harvard University Press, Cambridge, Massachusetts, 1934.)

In healthy individuals the kidneys maintain an excellent control of fluid and electrolytes, but conditions such as renal failure, dehydration, and shock

anuria due to acute tubular necrosis, chronic renal failure, burns or circulatory failure. It also occurs in Addisonian crisis.

Assessment of Type of Disturbance

In each case of suspected electrolytic disturbance it is essential to take a clear history and make a careful examination. An accurate record of fluid intake and output is also necessary. Estimation of plasma Na, K, Cl⁻ and alkali reserve, together with a blood urea are also important. The plasma specific gravity (normal 1.027) in the presence of normal plasma proteins is also a useful indication of the degree of dehydration as is the packed cell volume and hæmoglobin level, in the absence of anæmia. Simple bedside estimation of the amount of urinary chloride is also most useful as a guide to the plasma level, provided it is remembered that urinary chloride may be present with low plasma levels in Addison's disease, pyloric stenosis with potassium deficiency, salt-losing nephritis and conditions in which sodium loss has been greater than chloride loss, e.g., intestinal fistulæ. Chloride may be absent in the urine when salt depletion has been relieved and even when œdema is present, e.g., in hypoproteinæmia and depressed renal function with reduced glomerular filtration.

While most cases of electrolytic disturbance are "mixed," it is convenient, if somewhat artificial, to consider the symptomatology of the commoner types of upset.

1. *Water Intoxication.* Nausea, gain in weight, throbbing headache, hypertension, confusion, hallucinations and convulsions.

2. *Water Deficiency.* Thirst, dehydration, scanty urine with a high specific gravity, urinary chlorides often increased, blood pressure normal until late, plasma chlorides normal or raised and blood urea only slightly raised.

3. *Salt Depletion.* Thirst is absent. Dehydration, lassitude, cramps, vomiting, normal amount of urine until late, with a low specific gravity, urinary chlorides usually absent, hypotension and fainting, with a considerably raised blood urea.

4. *Sodium Intoxication.* Œdema, peripheral or pulmonary, with a raised jugular venous pressure.

5. *Potassium Deficiency.* Muscular weakness, paralysis, decreased tendon reflexes, and electrocardiographic changes, S-T segment depression, with T-wave inversion sometimes, and a prominent U-wave.

6. *Potassium Intoxication.* Muscular weakness, ventricular fibrillation and atrial arrest. The electrocardiogram shows the changes described on p. 489.

Treatment. This is directed at correction of previous losses and present abnormal losses, together with maintenance of basic daily requirements of fluid and electrolytes. Intravenous therapy is often necessary, particularly if the patient is vomiting. Basic requirements of fluid and salt in 24 hours can be given as 1 litre of normal saline and 1.5 to 2 litres of 5% dextrose (which electrolytically amounts to giving water) or as 2½ to 3 litres of 1/5 normal saline with 4.5% dextrose.

In diarrhoea there is loss of water and also of Na, K and Cl'. As pancreatic secretions contain excessive amounts of Na, more Na is lost than Cl', and B is diminished more than Cl'. R is increased once more and so HCO_2 is diminished, giving rise to acidosis. A similar type of electrolyte and water disturbance occurs in intestinal obstruction.

In diabetic ketosis both columns are reduced, due to renal disability caused by rapid dehydration. In the acid column, ketone acids are present and this, together with an increase in R, occurs at the expense of the bicarbonate, so that the patient is acidotic as well as hypochloræmic.

Causes of Electrolytic Disturbances

1. *Salt Depletion.* Pure salt depletion is commonly due to abnormal loss of water and electrolytes with subsequent replacement of water alone. Salt depletion also occurs in renal disease, such as chronic nephritis and pyelonephritis, acute tubular necrosis, and in renal dysfunction due to hormonal disturbances, as in Addison's disease and hypopituitarism, as the kidney does not reabsorb sodium normally. Excessive loss of salt and water in the urine occurs in diabetes mellitus with ketosis. Extrarenal loss occurs in chronic diarrhoea, intestinal fistulae, vomiting and sweating. Excessive diuresis in a patient on a low salt diet may also lead to salt depletion.

2. *Water Depletion.* This is less common than salt depletion. It occurs in patients who cannot or will not drink fluids, e.g., dysphagia, old age or coma. Mixed salt and water depletion is, of course, more frequent than either pure salt or pure water lack.

3. *Sodium and Water Excess.* Water excess only occurs if there is renal impairment, e.g. in acute tubular necrosis, or in the early post-operative period. Sodium excess is almost always accompanied by excess of water and occurs in hypoproteinæmia, the nephrotic syndrome, congestive heart failure, acute nephritis, cirrhosis of the liver, therapy with cortisone, ACTH, DOCA and testosterone. It also occurs in excessive progesterone secretion (premenstrual).

4. *Potassium Depletion.* Conditions under which this is liable to occur include diarrhoea, continued aspiration of gastro-intestinal contents, vomiting, starvation (as the kidney is unable to conserve potassium as efficiently as it conserves sodium and there is breakdown of the protoplasmic tissues releasing potassium), diabetic ketosis in the recovery phase, Cushing's syndrome and cirrhosis of the liver with ascites. It may also occur during therapy with ammonium chloride, the steroid hormones, para-aminosalicylic acid, and after prolonged treatment with diuretics, especially of the thiazide group. The rare condition of primary aldosteronism results in excessive excretion of potassium in the urine. Potassium depletion may also arise in patients who indulge in long continued and excessive purgation, and in the polyuric phase of acute renal failure.

5. *Potassium Excess.* This is found in patients with oliguria or

CHAPTER VII

THE HÆMPOIETIC AND RETICULO-ENDOTHELIAL SYSTEMS

Introductory. The hæmopoietic system is concerned with the production during life of the formed elements of the blood. According to the polyphyletic view the red cells and granulocytes are produced by the bone marrow, the lymphocytes develop in lymph nodes and lymphatic tissues generally, and the monocytes are derived from the reticulo-endothelial system. The megakaryocytes in the bone marrow throw off pseudopodia which pass through the walls of the sinusoids, are constricted off, and form platelets. Certain factors are required for the maturation of the red cells. The primitive marrow cell (hæmocyctoblast) is converted into a proerythroblast (megaloblast), possibly with the aid of an unknown agent. The active principle from the liver and stomach, folic acid, and perhaps the vitamin B complex aid in the change from proerythroblast to normoblast. Iron, copper, thyroxine and possibly vitamin C are concerned with the change from normoblast to erythrocyte. The reticulo-endothelial cells are branched connective-tissue cells with affinity for special dyes such as pyrrhol-blue. They are widely distributed in the spleen, liver, bone marrow, omentum, adrenals, the pituitary, etc. Red cell destruction is effected by the reticulo-endothelial cells in the spleen and liver, and possibly elsewhere. The total blood volume is approximately 5 litres.

The following examinations of the blood or bone marrow may be required in the investigation and treatment of diseases in this group :

1. *A Blood Count.* A normal blood count for an adult is as follows : Red cells, average for both sexes, 5,000,000 per c.mm. Hb. average normal for males and females, Haldane standard is 100%, or 14.8 G. Hb./100 ml. References to Hb.% in this book are those of the Haldane standard. The size, shape and staining properties of the red cells are noted. Normally no nucleated red cells are seen, except in an infant for a few days after birth. Reticuloocytes are immature red cells showing with vital stains a reticulum in their cytoplasm, and normally present to the extent of 0.5 to 1%. They are the same cells as exhibit polychromasia when stained in a dry film. An excess of reticuloocytes in the blood indicates that the red cells are being rapidly put forth into the circulation. The hæmoglobin content of each average red cell is indicated by (a) *The Mean Corpuscular Hb.* This is the weight of Hb. in each average cell. The normal mean is 29.5 $\gamma\gamma$ ($\gamma\gamma = 0.0000000001$ mg.). (b) *The Mean Corpuscular Hb. Concentration.* This indicates the degree to which each red cell is saturated with Hb. The normal mean is 33%. A reading below 32% indicates iron deficiency. (c) *The Colour Index.*

In estimating the extra electrolytic requirements which need to be added to the above fluids, the following are rough guides :—

1. For every 100 mg. (17 mEq./L.) the plasma Cl' needs raising to normal (585 mg./100 ml. or 103 mEq./L.) give 0.5 G. (8.5 mEq.) of NaCl per kg. of body weight.

2. For every integer the specific gravity of the plasma is above 1.027, give 200 ml. of fluid, usually as 100 ml. of normal saline and 100 ml. of 5% dextrose, assuming a mixed water and salt deficiency.

3. For each 1 mEq. the plasma bicarbonate has to be raised to normal level (27 mEq./L.) give 4.4 ml. of 1/6 M sodium lactate per kg. of body weight, provided the acidosis is a metabolic one, and the pH of the blood is decreased.

"Normal" saline contains 9 G. of NaCl per litre. Although it is isotonic with the blood, it is by no means physiological as each litre contains 154 mEq. of Na and Cl' , which is higher than the normal plasma level. Hence it cannot be given indiscriminately as if it were truly a physiological solution, although in the presence of normal renal function the excess chloride is usually excreted in the urine.

Potassium supplements should never be given by mouth or intravenously in the absence of an adequate urinary output, *e.g.*, 1,500 ml. per day. The basic daily requirements are 60 mEq., and this may be given by mouth as 3 to 5 G. of KCl, in the absence of any food intake. Enteric coated tablets containing KCl should not be used, due to the danger of small bowel ulceration. Intravenously it may be given as 2.23 G. of KCl per litre in 2 of the 3 litres of fluid given each day. It should never be given at a rate faster than 1 litre of such fluid in 3 hours. Additional potassium must be administered if there are previous losses. In this connection it is important to remember that in the absence of an adequate calorie intake, the daily loss of potassium in the urine will be increased, due to breakdown of protoplasmic tissue. A useful potassium mixture for oral use consists of 1 G. each of potassium acetate, bicarbonate and citrate made into a mixture, and given 2 to 3 times a day to cover basic requirements. It is less unpleasant for the patient to take than is KCl. Effervescent potassium tablets (BPC), each containing 6.5 mEq. of potassium, are another palatable preparation, but they also do not contain chloride.

In conclusion, it must be stressed once more that for correction of fluid and electrolyte losses, it is essential to have an accurate record of fluid and electrolyte intake and output.

Cells in Normal Bone Marrow Smears

(Percentages)

Hæmocyto blasts	.	.	.	.	.	.	0 to 1
Proerythroblasts	.	.	.	.	.	.	0 to 4
Early and intermediate normoblasts	.	.	.	.	.	.	4 to 15
Late normoblasts	.	.	.	.	.	.	7 to 10
Mycloblasts	.	.	.	.	.	.	0 to 2.5
Promyelocytes	.	.	.	.	.	.	0.5 to 5

		Neutrophil	Eosinophil	Basophil
Myelocytes	.	2 to 8	0 to 1	
Metamyelocytes	.	10 to 25	0 to 2.5	
Polymorphs	.	10 to 40	0 to 4	0 to 1

Lymphocytes	.	.	.	.	.	5 to 20
Monocytes	.	.	.	.	.	0 to 5
Plasma cells	.	.	.	.	.	0 to 1

Total cell count 25,000 to 100,000 per c.mm.
 Myeloid to nucleated red cells ratio 2 : 1 to 8 : 1.

9. *Blood Grouping.* The red cells may contain agglutinogens A or B, or both, or none; and the serum may contain agglutinins α or β , or both, or none. Agglutinin α or β causes agglutination of corpuscles containing agglutininogen A or B, respectively. Four Landsteiner ABO groups are described, according to the corpuscular agglutininogen content.

Group	Corpuscular Agglutininogen	Serum Agglutinin
A, B or 1 . . .	AB	0
A or 2 . . .	A	β
B or 3 . . .	B	α
O or 4 . . .	O	$\alpha + \beta$

There are also Landsteiner sub-groups, such as A_1 , A_2 , A_1B and A_2B . Further the serum from group B donors may contain α , α_1 , and α_2 agglutinins. The Rhesus factor is described on p. 96. Blood grouping has become more complicated by the discovery of other factors such as the Lutheran, Kell, M, N, P and S factors which may cause incompatibility.

Donors. Group AB may give blood to Group AB; Group A to A or AB; Group B to B or AB; and Group O is a universal donor. *Recipients.* Group AB is a universal recipient: Group A may receive blood from A or O; Group B from B or O, and Group O from O. It is better to use the blood of a donor of the same group as the recipient, rather than that of a universal donor. Further, the serum of the recipient should always be tested against the corpuscles of the donor.

This indicates the amount of Hb. in each average red cell, and taking as arbitrary normal figures, Hb. 100%, and red cells 5 millions, the C.I. is

$\frac{\text{Hb. \%}}{\text{Red Cells \%}}$ The normal figure is 1. (d) *The Saturation Index.* This

indicates the degree to which each average red cell is saturated with Hb., as shown by comparing the mean corpuscular Hb. concentration of the blood in question with the normal mean corpuscular Hb. The normal saturation index is 1.

The size of each average red cell is indicated by: (a) *The Mean Corpuscular Diameter.* The normal average is 7.2μ . (b) *The Mean Corpuscular Volume.* The normal average is $87\text{c}\mu$. (c) *The Volume Index.* This indicates the volume of an average red cell of the blood in question compared with the normal average red cell volume. The normal figure is 1. The average life of a red cell is about 120 days; it is destroyed by disintegration. White cells: 6,000 to 9,000 per c.mm. Differential white count. Granulocytes. These include: Polymorphonuclears (neutrophils) 50 to 65%, eosinophils 1 to 4%, mast cells (basophils) 0.25 to 1%. Lymphocytes (small) 15 to 25%. Lymphocytes (large) 5 to 15%. Large mononuclears (monocytes, hyaline or transitional cells) 4 to 6% (see Fig. 49). The average life of a polymorphonuclear cell is four days, and of a lymphocyte less than a day.

2. *A Platelet Count.* Normally there are 200,000 to 500,000 platelets per c.mm.

3. *Fragility of the Red Cells.* Normally hæmolysis does not occur in solutions of sodium chloride, until the percentage of NaCl has been lowered from that of normal saline (0.9%) to a strength of 0.45%. With increased fragility hæmolysis may begin at 0.65% NaCl and be complete at 0.5%.

4. *The Bleeding Time.* A small cut is made in the ear or finger. Drops of blood are taken up on absorbent paper every 30 seconds, until bleeding stops. The normal time is 1 to 5 minutes.

5. *The Coagulation Time.* This varies with the method used, and a control should always be made to allow a normal reading as a comparison. The normal time by Lee and White's method is 4 to 7 minutes.

6. *The Sedimentation Rate of the Red Cells.* By the Westergren method, in which the tube is divided into 200 mm., the normal reading at one hour is plasma 1 to 5 mm. for men, and for women plasma 4 to 7 mm. By Wintrobe's method the normal sedimentation reading at one hour is plasma 0 to 9 mm. for men, and for women plasma 0 to 15 mm.

7. *The Estimation of Prothrombin in Plasma.* The clotting time of oxalated plasma, when mixed with an excess of thrombokinase and an optimum amount of calcium, is employed as a direct measure of the prothrombin content of the plasma. Using the method of Quick, normal plasma (100% prothrombin) should clot in 12 to 18 seconds.

8. *Sternal Puncture.* 0.25 ml. of marrow fluid is removed by puncture of the sternum, using a Salah needle and dry syringe. The fluid is put in a tube containing Wintrobe's dry oxalate mixture, smears are then stained by Leishman's method.

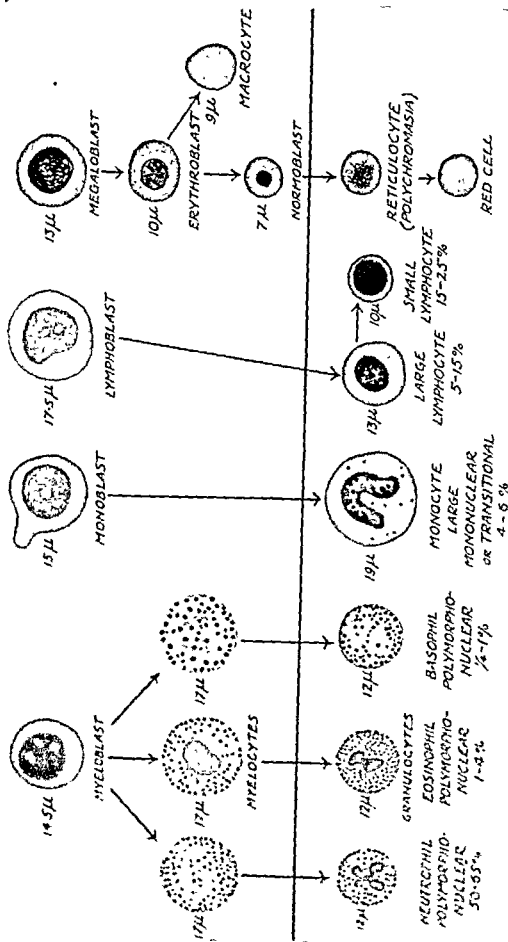


FIG. 19. THE BLOOD CELLS AND THEIR PRECURSORS ($\times 1,000$). THE CELLS BELOW THE LINE ARE NORMALLY PRESENT IN BLOOD.

typing, and in determining the Duffy blood group. In brucellosis, by doing the indirect test using the patient's serum and bacteria, immune bodies are adsorbed on the bacteria.

Various abnormal cells may appear in the blood in disease.

1. *Abnormal red cells.* Macrocytes are large non-nucleated cells. Microcytes are small non-nucleated cells. Megaloblasts and erythroblasts are large nucleated cells. Normoblasts are normal-sized nucleated cells. The red cells may exhibit polychromasia (staining diffusely a bluish colour) or punctate basophilia (showing blue granules). Target cells have a darkly stained central area. Red cells may be irregular in size (anisocytosis) or in shape (poikilocytosis and sickle cells).
2. *Abnormal white cells.* Precursors of granulocytes: These are premyelocytes with oval nuclei, myelocytes with indented nuclei, and metamyelocytes with a lobed nucleus. These cells may contain neutrophil, eosinophil or basophil granules, and are classed accordingly. The parent cell of the myelocyte is called a myeloblast, and that of the lymphocyte is a lymphoblast (see Fig. 49). It is often very difficult to distinguish between a large immature lymphocyte (lymphoblast) and a myeloblast. The myeloblast is slightly smaller, and often the oxidase test shows that the cytoplasm is granular. In the very early stages, however, the oxidase test is negative. The oxidase test is negative with the lymphoblast, the cytoplasm being agranular. Plasma cells are rarely found in the peripheral blood in such conditions as multiple myelomatosis, measles, German measles and leukæmia.

Leucocytosis

Definition. An increase in the number of white cells in the blood.

Etiology. Physiological leucocytosis occurs after meals, exercise, cold baths, and during labour and the first week of the puerperium. In children there is a physiological lymphatic leucocytosis. In pathological leucocytosis the different types of white cell may be unequally affected. *Polymorphonuclear leucocytosis:* This is met with in infections, in lobar pneumonia, in paroxysmal tachycardia, in coronary occlusion, in diabetic coma and after an acute hæmorrhage. 90% of the white cells may be neutrophil polymorphonuclears. *Lymphatic leucocytosis:* This occurs in lymphatic leukæmia, glandular fever, whooping-cough and sometimes in mumps. Up to 90% of the white cells may be lymphocytes. *Eosinophilia:* This is found in asthma, in parasitic infections such as ankylostomiasis and hydatid disease, in skin diseases such as psoriasis, urticaria and dermatitis herpetiformis, in dermatomyositis, and at times in acute polyarteritis nodosa, Hodgkin's disease or leukæmia, in chronic abdominal tuberculosis, or it may occur as a familial condition of unknown etiology. Up to 70% of the white cells may be eosinophils. A condition of eosinophilia with splenomegaly is described, due to syphilis, Hodgkin's disease, malaria or some unknown cause. In 1943 Weingarten described what he called a new disease, tropical eosinophilia. This is met with in India and is characterised by severe spasmodic bronchitis, leucocytosis and an eosinophilia

of up to 89%. X-ray examination shows a diffuse mottling of the lung fields. Many of these cases have been shown to be due to a filarial infection. The condition usually responds rapidly to intramuscular injections of Acetylarsan. The solution for adults contains 50 mg. arsenic per ml., and the dose is first 0.5 ml., then 1 ml. and subsequently 2 ml. The injections are given twice weekly for 5 weeks. Better results are obtained with diethylcarbamazine (Hetrazan) tablets (50 mg. each) given by mouth, 8 mg./kg. body weight for 4 to 16 days. Loeffler, in 1932, described a somewhat similar condition, an eosinophilia, with shadows, as shown by X-ray examination, in the lung fields. *The mast cells* may be increased to about 20% in myeloid leukæmia. *The large mononuclears* may increase in infections such as malaria, syphilis or trypanosomiasis.

Leucopenia

Definition. A diminution in the number of white cells in the blood.

Etiology. *Physiological leucopenia*: This occurs in old age and in starvation. *Pathological leucopenia*: This may be met with in tuberculosis, influenza, typhoid fever, pernicious anæmia, splenic anæmia, hypersplenism, Hodgkin's disease, after exposure to radium, in phosphorus and benzol poisoning, in aplastic anæmia and in agranulocytic angina.

Thrombocytosis

A temporary increase in the platelet count occurs after a hæmorrhage, childbirth and splenectomy. It is met with in polycythæmia vera, chronic myeloid leukæmia, Hodgkin's disease, in the remissions of pernicious anæmia, and in the anæmia of chronic sepsis, tuberculosis, carcinoma, etc. Thrombocythæmia is described on p. 560.

ANÆMIA

Anæmia results from a deficient formation of red cells or from their excessive destruction. Wintrobe, in 1930, grouped some of the anæmias according to the size and hæmoglobin content of the red cells. It should be realised that although a red cell may contain less hæmoglobin than normal in proportion to its size (hypochromic anæmia), the proportional amount of hæmoglobin is never increased. There is therefore no such condition as hyperchromic anæmia, the high colour index in pernicious anæmia being due to large red cells containing a normal percentage of hæmoglobin. Wintrobe classified the anæmias as macrocytic, normocytic, simple microcytic and microcytic hypochromic. If the red cells are saturated with hæmoglobin, the megaloblastic anæmias are benefited by vitamin B₁₂ or by folic acid, and the hypochromic anæmias by iron. Iron is, however, required for megaloblastic anæmias, if the saturation index is low.

Davidson, in 1932, put forward a classification with an etiological basis. The following classification is that of Davidson with some modifications: 1. *Nutritional deficiency anæmias*. These may be due to: (a) Lack of the hæmopoietic principle (see p. 523). This occurs as a primary

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ANÆMIA

Anæmia results from a deficient formation of red cells or from their excessive destruction. Wintrobe, in 1930, grouped some of the anæmias according to the size and hæmoglobin content of the red cells. It should be realised that although a red cell may contain less hæmoglobin than normal in proportion to its size (hypochromic anæmia), the proportional amount of hæmoglobin is never increased. There is therefore no such condition as hyperchromic anæmia, the high colour index in pernicious anæmia being due to large red cells containing a normal percentage of hæmoglobin. Wintrobe classified the anæmias as macrocytic, normocytic, simple microcytic and microcytic hypochromic. If the red cells are saturated with hæmoglobin, the megaloblastic anæmias are benefited by vitamin B₁₂ or by folic acid, and the hypochromic anæmias, if the saturation index is low.

binds B_{12} into a non-diffusible complex which prevents it from being digested in the intestine. Further, if vitamin B_{12} is injected parenterally it becomes active because it is bound to a substance in the tissues, and it exists in the blood in the bound form. This union is destroyed by heat, the vitamin B_{12} being thus rendered hæmopoietically inactive. The hæmopoietic principle is absorbed in the ileum and is carried to the liver and other organs, and stored in the liver, and to a lesser degree in the kidneys and spleen. In its absence pernicious anæmia develops owing to the failure of conversion of megaloblasts into erythroblasts and normoblasts in the bone marrow. When these megaloblasts are liberated into the blood stream they are destroyed by the cells of the reticulo-endothelial system. The iron, which is deposited in the spleen, liver and kidneys, and the excess of bilirubin in the blood, are in part due to this hæmolysis, and in part to the failure of the bone marrow to utilise these substances in the production of red cells.

In pernicious anæmia the B_{12} in the food is not absorbed owing to the absence of the "intrinsic" factor from the gastric juice. Achylia gastrica has been demonstrated in the majority of cases, the gastric juice showing no free HCl , pepsin or rennin after the intramuscular injection of histamine. In *pernicious anæmia in childhood* free acid is present in the gastric juice and there is no gastric mucosal atrophy. The secretion of the intrinsic factor is, however, absent. Gastric carcinoma does not cause pernicious anæmia because the patient dies before the body stores of B_{12} are exhausted. This takes 3 to 8 years. Pernicious anæmia may be an autoimmune disease as antibodies to parietal gastric mucosa cells and to intrinsic factor are found in the serum. There is no folie acid deficiency.

Sturgis and Isaacs have shown that the intrinsic factor is present in dried whole hog's stomach.

Predisposing causes: 1. Age: Usually after 35 years. 2. Sex: No definite difference. 3. A familial incidence is noted in some cases. It is said to be more common in blood group A than in group O. 4. Extensive gastrectomy, up to 30% of such cases may develop pernicious anæmia.

defect (the diet being adequate) in pernicious anæmia, and as a secondary defect (*i.e.*, resulting from some recognisable cause) in the anæmia of sprue, dysentery and tropical megaloblastic anæmia, in the pernicious anæmia of pregnancy, in *Diphyllobothrium latum* infestation, in carcinoma of the stomach and after gastrectomy. In this latter group there is also often an error in iron assimilation. There may be a deficiency of storage of the hæmopoietic principle in advanced cirrhosis of the liver.

(b) Lack of the factors required for hæmoglobin formation such as iron and possibly copper, calcium, thyroxine, vitamin C, chlorophyll, and a salt balance in the food. This also may be a primary defect as in the simple achlorhydric anæmia and the Plummer-Vinson syndrome where the food intake is often satisfactory; or secondary to a recognisable food or endocrine defect, as in the simple nutritional anæmia of infants, chlorosis, chronic gastritis and enteritis, coeliac disease, starvation, prolonged milk feeding as in the treatment of peptic ulcers, and in myxædema and thyrotoxicosis.

2. *Post-hæmorrhagic anæmias*. These occur after acute or chronic hæmorrhage.

3. *Hæmolytic anæmias*. (a) Acute hæmolysis may result from black-water fever, malaria, paroxysmal hæmoglobinuria, septicæmia, or toxins, such as snake venom. It also occurs in Lederer's anæmia.

(b) A persistent hæmolysis, as in congenital or acquired acholuric jaundice, sickle-cell anæmia, Cooley's anæmia, and lead poisoning.

4. *Anæmias due to inhibition of the bone marrow function*. These may be primary, as in aplastic anæmia, or secondary, as in aplastic anæmia due to noxious agents such as X-rays, radium emanations, benzol, lead or mercury. A leuco-erythroblastic anæmia occurs, owing to involvement of bone marrow, in carcinomatosis, myelomatosis, in osteosclerosis including the marble bone disease of Albers-Schönberg, in myelosclerosis, in Hodgkin's disease, xanthomatosis of bone, in Gaucher's disease, in acute hæmolytic anæmia and in acute infections. Nucleated red cells are found in the blood in numbers greater than would be expected from the anæmia. There may be as many as 50 normoblasts for every 100 leucocytes. There may also be occasional myelocytes and myeloblasts.

NUTRITIONAL DEFICIENCY ANÆMIAS

Pernicious Anæmia

(Addisonian Anæmia)

Definition. A severe megaloblastic anæmia, characterised by a typical blood and bone marrow picture, and, if untreated, a progressive course which is often interrupted by remissions.

Etiology. Pernicious anæmia results from the lack of a hæmopoietic principle which has been isolated from the liver as vitamin B₁₂ or cyanocobalamin. It can also be prepared from the liquor obtained in the growth of *streptomyces griseus*. Castle's "extrinsic" factor, which is vitamin B₁₂, is present in protein food. In order that it may become hæmatopoietically active it must be bound to the "intrinsic" factor, which is a mucoprotein secreted in the upper part of the stomach. It

gastrica, no free HCl being secreted after injection of histamine. The juice also lacks pepsin and the "intrinsic factor." Rarely the juice contains acid and pepsin, but the "intrinsic factor" is absent. The stomach empties rapidly. Blind gastric biopsy, using a flexible gastric biopsy tube, shows atrophy of the gastric mucosa in pernicious anæmia and in subacute combined degeneration of the cord. The serum B_{12} content is below the normal low level of $140\mu\mu$ g./ml.

Differential Diagnosis. The diagnosis of pernicious anæmia depends upon the typical blood count, with megalocytosis, high colour index, and the presence of large nucleated red cells, the bone marrow findings, and the fractional test meal showing an achylia and absence of the "intrinsic" factor. During the remission phases, although nucleated red cells may be absent in the blood film, yet the average size of the red cells remains greater than normal. In carcinoma of the stomach the blood count may closely resemble that of pernicious anæmia. The X-ray findings and occult blood test are usually helpful. In sprue and infections with the *Diphyllobothrium latum* the blood picture may be similar to that of pernicious anæmia, but achylia is not present. In the megalocytic anæmia of pregnancy the gastric juice contains free hydrochloric acid. If there is much pigmentation Addison's disease may be suspected. The blood count serves to differentiate. Patients thought to be suffering from pernicious anæmia may not have this disease, but some lesion in the small intestine. The erroneous diagnosis of pernicious anæmia may have been made by finding achlorhydria in the ordinary test. More delicate tests for achlorhydria may reveal the presence of free hydrochloric acid. In the augmented histamine test an anti-histamine, mepyramine, 25 to 50 mg. tab., is given to diminish the side effects of histamine. A subcutaneous injection of histamine, 0.04 mg./kg. body weight, is then given, and the gastric juice is collected for a fixed period by continuous motor pump aspiration through a polythene tube. Precise and reproducible data are obtained.

With tubeless gastric analysis a cation exchange resin, which is dissociated by hydrochloric acid, is given by mouth. It is absorbed and excreted in the urine and its amount estimated. The resin used is azuresin or diagnex blue. In the test an intramuscular injection of antazoline (Antistin) 200 mg. is given, followed 15 minutes later by a subcutaneous injection of 0.04 mg. histamine acid phosphate per kg. body weight. A control specimen of urine is collected 30 minutes later. The patient is then given by mouth 2 G. azuresin with a glass of water, and the dye in the urine passed in the next 2 hours is estimated colorimetrically. Positive results are usually accurate, but false negative results occur.

In pernicious anæmia in addition to the achlorhydria and the presence of megalocytes in the blood, there are megaloblastic changes in the bone marrow, a low serum level of vitamin B_{12} , mal-absorption of oral radioactive vitamin B_{12} , and a reticulocyte response to B_{12} therapy. Postero-lateral sclerosis may occur before the development of the typical blood picture of pernicious anæmia. Achrestic anæmia (αρεστική αναιμία) is described by Wilkinson and Israëls. The anæmia

and occasionally by the spleen and kidneys, on applying a 2 to 5% solution of potassium ferrocyanide followed, after washing, by 5 to 10% hydrochloric acid. The red marrow of the bones is increased, especially in long bones, such as the femur. Degeneration may be found in the postero-lateral columns of the cord.

Clinical Findings. The patient is usually an adult between the ages of 40 and 70 years. Very rarely pernicious anæmia occurs in children. He complains of progressive weakness, increasing pallor with dyspnœa on exertion, palpitations, and at times anginal pains due to anoxia of the heart muscle. In some cases swelling of the feet or ankles may be noted. There may be soreness of the tongue, numbness or tingling in the legs and hands, vomiting or diarrhœa. Failing vision, due to optic atrophy, may be the first symptom. The atrophy is secondary to a retrobulbar neuritis, the lesion being near the chiasma. Other neurological evidence of subacute combined degeneration may be very slight.

On Examination : The nutrition of the patient is usually good. The tongue may be very smooth. The skin is pale, with at times a lemon-yellow tint. The hair may be prematurely grey. There may be cutaneous pigmentation with areas of leucoderma, and small petechiæ may be seen. The spleen is enlarged in about 8% of cases and the liver may be palpable. Evidence of postero-lateral spinal sclerosis may be found, such as patchy anæsthesia of the legs, weakness of muscles and an extensor plantar response. Cases in which there is tenderness of the calves, weakness of the legs, tingling, numbness, and depressed tendon reflexes, may be suffering from peripheral neuritis or an early stage of subacute combined degeneration. Loss of vibration sense is often the earliest sign of a spinal medulla (cord) lesion. In some instances there is definite jaundice and ascites. The blood : A typical count during a relapse phase is as follows : Red cells, 500,000 to 2,500,000 per c.mm. Hb., 12 to 65% (1.8 to 9.6 G. Hb./100 ml.) C.I., 1.1. Mean corpuscular Hb 50γγ. Mean corpuscular Hb. concentration 33%. Saturation index 1. The average diameter of the red cells is 8.24μ (normal 7.2μ). Mean corpuscular volume 150 cμ. Volume index 1.5. The red cells show anisocytosis, poikilocytosis, megalocytosis, polychromasia and punctate basophilia. Normoblasts and megaloblasts are present. The platelets are reduced. Reticulocytes are increased to about 2%. White cells : There is a leucopenia, 4,000 to 5,000 per c.mm., with relative lymphocytosis up to 50%. The polymorphonuclears show a "shift to the right" in the Arneth count, many having a four or five lobed nucleus. There are usually some myelocytes present. The coagulation time : This is prolonged. The sedimentation rate : This is increased, owing to the anæmia alone and not to tissue destruction. The serum : An indirect van den Bergh reaction is given. The bone marrow obtained by sternal puncture in untreated cases shows 25 to 45% of the cells to be megaloblasts and erythroblasts, and premature hæmoglobinisation is present. The urine and fæces contain an excess of bile pigment. During treatment with vitamin B₁₂ an output of reticulocytes occurs before the number of red cells increases. The fractional test meal shows achylia

5. After gastrectomy, due to lack of the intrinsic factor and so to lack of absorption of B_{12} .

6. Infestation with *Diphyllobothrium latum*. The worm is thought to ingest vitamin B_{12} from the intestinal contents.

7. A blind loop or stagnant loop of small intestine. Bacteria in the intestinal contents are thought to utilise B_{12} . The blind loop may be due to strictures of the jejunum or ileum, following resection of a portion of intestine, or to diverticulosis of the upper small intestine.

8. Advanced liver disease which prevents storage of B_{12} and of folic acid.

9. Drugs such as phenytoin, primidone, barbiturates and pyrimethamine.

Simple Achlorhydric Anæmia (Faber)

(Idiopathic Microcytic Anæmia)

The patient is usually a woman of middle age. She complains of pallor, dyspnœa, swelling of the feet, palpitations, indigestion and, in a severe case, of anginal pain. The predominance in the female sex is probably due to uterine losses of blood. The food intake is often satisfactory but may be deficient in iron, or the iron is not adequately absorbed. Normally 15 mg. of iron per day are required.

On Examination: The skin is pale and often sallow. The nails are concave or spoon-shaped (koilonychia) in many cases, and brittle. Cracks are often seen at the corners of the mouth. The tongue is smooth, red, but not sore. The spleen may be enlarged. There are no changes in the spinal medulla (cord). The test meal shows a complete achlorhydria with rapid stomach emptying, and mucus is present in excess; there is usually some pepsin, and some HCl response to the intramuscular injection of histamine. Castle has shown that if beef is incubated with the gastric juice, the hæmopoietic principle of pernicious anæmia is produced even in specimens of histamine-refractory gastric secretions. This shows that the juice contains Castle's "intrinsic factor" and explains why the patient does not develop pernicious anæmia. Occasionally normal test meal findings are recorded. The van den Bergh test on the blood is negative; the fæces contain no occult blood. The blood count is that of a hypochromic microcytic anæmia with a low colour index, such as, red cells 3 to 4 millions per c.mm., Hb. 30 to 50% (4.4 to 7.4 G. Hb./100 ml.), C.I. 0.4 to 0.5. The majority of the red cells are smaller than normal. Complications include the Plummer-Vinson syndrome.

is megalocytic, the patient being unable to use the hæmopoietic principle. Free HCl is present in the gastric juice and there are no complications. It is resistant to vitamin B₁₂ therapy but may respond to folic acid 10 mg. daily by mouth.

Course and Complications. Remissions are common, during which the patient feels and is better, and the blood count improves. Blood crises may also be noted, characterised by the appearance of large numbers of nucleated red cells. Some cases pursue a course rapidly fatal in a few days or weeks, in others life is prolonged for 2 or 3 years. It is doubtful if permanent recovery, apart from treatment, ever occurs. Even after successful treatment the achylia nearly always remains. Complications include trophic ulcers on the buttocks and heels, pneumonia, nephritis and a tendency to develop gastric carcinoma.

Prognosis. The disease is fatal usually within two to three years if no treatment is given. The introduction of the vitamin B₁₂ treatment has revolutionised the outlook, and it is now very rare for a patient to die during the acute stage if adequate treatment is given.

Treatment. Vitamin B₁₂ (cyanocobalamin) should be given. It is available as Cytamen in ampoules containing 50, 100, 250 or 1,000 micrograms per ml. The initial dose is 1,000 micrograms intramuscularly twice in the first week, and then 100 micrograms, repeated daily until a remission is obtained. A maintenance dose of 50 to 100 micrograms should then be injected every 2 to 4 weeks for an indefinite period. Higher serum B₁₂ levels are obtained with the use of hydroxocobalamin (Neo-cytamen). An initial daily dose of 1,000 micrograms is injected on 4 alternate days followed by 1,000 micrograms every 2 to 3 months. The state of the disease should be checked by periodical blood counts.

In the later stages of the initial treatment there is often iron deficiency, as shown by a mean corpuscular Hb. concentration of under 80%. Iron should then be given as ferri et ammon. cit. 80 to 45 gr. (2 to 3 G.), t.i.d., and iron is also valuable when nervous symptoms are present. Folic acid must not be used in the treatment of pernicious anæmia owing to the risk of neurological complications developing.

The Megaloblastic Anæmias

In addition to pernicious anæmia and in some cases of hypothyroidism this group includes:—

1. The pernicious anæmia of pregnancy, due to excessive demands for folic acid in the diet.
2. Tropical megaloblastic anæmia, due to insufficiency of folic acid in the diet.
3. Megaloblastic anæmia due to dietary folic acid deficiency in certain gastric disorders and psychiatric conditions.
4. The megaloblastic anæmia of sprue and of idiopathic steatorrhœa, due to lack of absorption of vitamin B₁₂ and of folic acid. Other intestinal causes include regional ileitis, malignant reticuloses and tuberculosis. Excessive excretion of formiminoglutamic acid (Figlu) in the urine after giving histidine by mouth is an indication of folic acid depletion.

several weeks. A rapid loss of one-third of the total blood volume usually proves fatal.

Clinical Findings. A severe hæmorrhage results in pallor, restlessness, a feeling of sinking through the bed, thirst and faintness. The pulse is frequent and its volume small. The blood nitrogen may rise and uræmia ensue.

Treatment. A blood transfusion is required in severe cases. The recipient should be given sufficient alkali by mouth to render the urine alkaline before the transfusion, as this will tend to prevent a tragedy due to hæmolysis and precipitation of acid hæmatin in the renal tubules. In other cases iron should be given in large doses such as ferri et ammon. cit. 30 gr. (2 G.) t.i.d.

The Anæmia of Chronic Hæmorrhage

Etiology. This anæmia results from repeated small hæmorrhages which may be due to such causes as pulmonary tuberculosis, hæmorrhoids, aspirin, carcinoma of the alimentary tract, etc.

Clinical Findings. The anæmia is of the microcytic hypochromic type, with a low colour index and the average red cell is smaller than normal.

Treatment. This consists in the establishment of measures to stop the bleeding, and the administration of iron.

THE HÆMOLYTIC ANÆMIAS

Acute Hæmolysis

In the hæmolytic anæmias there is an increase in the number of reticulocytes in the blood for a period of time, with no corresponding rise in the blood count; there is also an excess of bile pigment in the blood. With rapid blood destruction there is hæmoglobinuria and excess of urobilinogen in the urine and fæces.

The hæmolytic anæmias may be classified as follows:—

Hereditary. These are due to intracorpuseular causes, such as changes in the shape, size and thickness of the red cells, associated with abnormal forms of hæmoglobin. They include congenital acholuric jaundice, sickle-cell anæmia, thalassæmia, and paroxysmal nocturnal hæmoglobinuria. **Acquired.** The anæmia is due to extracorpuseular causes, to substances in the plasma which result in hæmolysis. They include:—

1. Infections. Especially malaria and *Cl. Welchii* septicæmia.
2. Chemical substances. Lead, phenylhydrazine, sulphonamides, phenacetin, arsenic, phosphorus, quinine, and trinitrotoluene.
3. Allergy. Idiosyncrasy to the bean *vicia faba*.
4. Immune reactions. Mismatched blood transfusion, erythroblastosis foetalis, paroxysmal cold hæmoglobinuria, virus pneumonia, and idiopathic acquired hæmolytic anæmias of unknown origin, including Lederer's anæmia. Symptomatic hæmolytic anæmia may be an early manifestation of systemic lupus erythematosus, it may also

injection. The total amount of elemental iron required is 24.5 mg. for each 1% deficit of hæmoglobin, as determined on the Haldane scale, plus 50% to restore the iron reserves in the tissues to normal. A preparation of saccharated iron oxide such as Ferrivenin may be used, injecting 50 mg. on the first day, 100 mg. on the second and subsequent days, until the calculated dose is given. Great care must be taken that none of the fluid extravasates outside the vein. The injection must be made slowly, about 2 ml. a minute, otherwise venospasm may occur. The ampoules contain 100 mg. per 5 ml. Reactions such as flushing, dizziness, sweating, pallor, dyspnoea, vomiting, diarrhoea, and even loss of consciousness may occur. The total amount injected should never exceed 1 G. for fear of provoking hæmosiderosis, and a second course should not be given until 3 months have elapsed. Objections have been raised to the intramuscular injection of iron-dextran owing to the possible danger of malignant changes occurring later at the site of injection. A blood transfusion may be required in very severe cases.

The Plummer-Vinson Syndrome

This is described on p. 18.

The Nutritional Anæmia of Infancy.

This is due to deficiency of iron and minerals in milk, and is curable by the administration of iron. The following mixture is used: Ferri et ammon. cit. $1\frac{1}{2}$ gr. (0.1 G.), aq. chlorof. 60 m. (4 ml.). Add 2 to 3 drops of the mixture to the feeds three times a day, and gradually increase up to 60 m. (4 ml.) t.i.d. The mother also is frequently anæmic.

Chlorosis

(The Green Sickness)

Chlorosis, which was so common in the early part of this century in young women working in shops, is practically never seen now. The characteristic features were the hypochromic anæmia, increased blood volume, excess of gastric hydrochloric acid and a greenish tinge in the skin. Now we occasionally see a similar condition in adolescent males and females, although the greenish tinge is lacking. The disease usually responds well to fresh air, correction of constipation, a diet containing meat and vegetables, and the administration of iron.

POST-HÆMORRHAGIC ANÆMIAS

The Anæmia of Acute Hæmorrhage

Etiology. The hæmorrhage may be external or internal, and due to various causes.

Pathology. The regenerative changes in the blood after a severe hæmorrhage include a polymorphonuclear leucocytosis, taking place within a few hours, followed by a more gradual dilution of the blood with fluid derived from the connective tissue spaces. Reticulocytes (up to 5%) are seen and the red cells show anisocytosis and polychromasia, with an occasional normoblast. The colour index is low for

sex distribution. The liability to the disease is transmitted as a dominant Mendelian character. The symptoms are usually noted before the age of 10.

Pathology. The spleen is moderately enlarged, but the capsule is not usually thickened. The pulp contains many red cells, which are ingested and destroyed by the endothelial cells. The red bone marrow is hyperplastic.

Clinical Findings. Often no symptoms are noted, but the patient may complain of jaundice, or of attacks of vomiting, or of weakness and anæmia.

On Examination : There is some icterus of the skin and conjunctivæ. The spleen is enlarged. Long-standing ulceration of the legs may be noted. The urine is dark and contains urobilin, but no bilirubin. The blood : The red cells are fragile, undergoing hæmolytic in 0.75% NaCl solution, whereas normally hæmolytic does not occur until the strength of the NaCl is lowered to 0.45%. The average diameter of the red cells is reduced (microcytosis). There is some anæmia, but the colour index is generally just under unity. A few normoblasts and an excess of reticulocytes are present. The white cells are normal. Blood crises occur in which there is a more marked anæmia, a leucocytosis, and the number of reticulocytes is increased. The crises may be due to increased hæmolytic or to aplastic changes in the bone marrow. The serum gives an indirect van den Bergh reaction, the jaundice being of a hæmolytic type. The feces are dark and contain stercobilinogen and stercobilin. Other congenital defects such as oxycephaly may be present.

Differential Diagnosis. This is established by the familial incidence, the microcytosis with jaundice, and the increased fragility of the red cells. A blood examination during a crisis may suggest a leucæmia or the acute hæmolytic anæmia of Lederer, owing to the leucocytosis with the presence of some primitive granulocytes.

Course and Complications. The disease does not necessarily produce any serious effects upon the patient's health, but an intercurrent septic infection may result in an "anæmic breakdown" later in life. Gallstones and deposits of urates around the joints may occur subsequently.

Prognosis. This is good with adequate treatment.

Treatment. Splenectomy will cure the condition as regards the jaundice and anæmia, although the fragility of the red cells after splenectomy is still greater than normal. It is only required in cases in which crises occur and should be performed in the remission stage, and a blood transfusion should only be given after careful cross-matching. In very severe crises splenectomy may be performed as an emergency measure after a small preliminary blood transfusion.

Acquired Acholuric Jaundice

(Acquired Hæmolytic Icterus)

Definition. A variety of acholuric jaundice appearing in adults.

Etiology. The cause is usually unknown, but in some cases the

occur in the reticuloses, in lymphosarcoma, carcinomatosis, rheumatoid arthritis, multiple myelomatosis, and in chronic leukæmia.

5. Hypersplenism. This results in a hæmolytic anæmia due to overactivity of the spleen and reticulo-endothelial system.

Lederer's Anæmia (Acute Febrile Anæmia)

Etiology. The cause is unknown, but the presence of hæmolysins in the blood is considered to be the exciting factor in some cases.

Pathology. The spleen may be enlarged with infarction and the bone marrow is hyperplastic, with an erythroblastic reaction.

Clinical Findings. The patient is usually an adult under the age of 20. He is suddenly taken ill with malaise, headache, fever of 100° to 104° F. (37.8 to 40° C.) and often a rigor, vomiting and epistaxis. The passage of dark urine (hæmoglobinuria) may be the first symptom.

On Examination : The patient may be slightly or definitely jaundiced and the urine may contain blood and bile pigments. The spleen may be palpable. The blood : Red cells, 2 millions per c.mm. or less. In children the red cells are usually macrocytic, but in adults they may be microcytic, normocytic or macrocytic. C.I., usually about 1. Some nucleated red cells may be present. The reticulocytes are increased. The white cells are usually increased (20,000 to 100,000 per c.mm.) and myelocytes and myeloblasts may be present. In children a lymphocytosis may occur, with up to 10% of lymphoblasts. The blood culture is sterile.

Differential Diagnosis. At the onset gastric influenza is often suspected. It may be difficult to differentiate the disease from acute leukæmia, unless recovery occurs.

Prognosis. Death may rapidly occur, or the temperature may fall to normal and the patient recover in a few weeks.

Treatment. An immediate blood transfusion, after very careful cross-matching, should be given and repeated if necessary. Prednisone may be given in doses of 5 mg. q.i.d. If there is not a good response splenectomy should be performed.

Chronic Hæmolysis

Chronic hæmolytic anæmia occurs in acholuric jaundice, in sickle-cell anæmia, and at times in Hodgkin's disease.

Congenital Acholuric Familial Jaundice

(*Hæmolytic Icterus. Hereditary Spherocytosis. Minkowski's Disease*)

Definition. A disease characterised by enlargement of the spleen, slight icterus and increased fragility of the red cells.

Etiology. Experimental evidence suggests that a defect, possibly metabolic, in the spherocytes causes them to be unduly fragile. No antibodies are found in the blood by Coombs' test, and transfused red cells survive normally. The spleen may destroy these abnormally thick and unduly fragile red cells. There is a familial incidence with an equal

(heterozygous state). If he receives it from both parents (homozygous state) he will suffer from sickle-cell anæmia.

Clinical Findings. In some cases there are no symptoms, the patient having only the sickle-cell trait, in which the red cells become sickle-shaped when incubated under a cover slip for longer than 24 hours. This is much more common than sickle-cell anæmia. In others, when both parents have the sickle-cell trait, the disease manifests itself by acute attacks in which the patient complains of weakness, pains in the muscles and abdomen, vomiting, diarrhoea, irregular fever and at times ulceration of the legs. Slight jaundice may be present. The blood: The red cells are diminished in number. The average size is slightly enlarged (Wintrobe). The sickle-shape appearance of the red cells is only seen in blood which is freshly drawn and allowed to stand under a sealed cover-slip. In about 12 to 24 hours over 60% of the red cells become elongated, and return to their normal shape in another 24 to 48 hours. There is anæmia of varying degree, with some nucleated red cells, polychromasia and reticulocytosis. The colour index is below unity. There is a leucocytosis of 12,000 per c.mm., or more. The fragility of the red cells is decreased and the indirect van den Bergh reaction is positive. If sickle-cells are transfused into a normal person they are quickly destroyed, but if normal cells are transfused into patients suffering from a sickle-cell anæmia, they survive normally.

Prognosis. Recovery rarely takes place, the patient usually developing an intercurrent infection before the age of 35.

Treatment. General hygienic measures should be adopted and a course of vitamin B₁₂ and iron treatment tried.

anæmia is associated with previous blood transfusions. Some authorities consider the disease is the same as congenital acholuric jaundice, differing only in quantitative rather than qualitative blood reactions. Symptomatic hæmolytic anæmia is also described occurring in various infections such as tuberculosis, malaria and syphilis, or in diseases such as carcinoma, cirrhosis of the liver, leukæmia, an ovarian tumour or a dermoid. Hypersplenism is another causative factor. A hæmolysin is present in acquired hæmolytic icterus as transfused red cells are rapidly destroyed. The Coombs test is positive, indicating a hæmolysin adsorbed to the red cells.

Clinical Findings. The patient is an adult, often of the female sex. The onset is frequently sudden with nausea, vomiting and jaundice. Later, attacks of biliary colic may occur.

On Examination : The spleen is enlarged. The blood : There is a hæmolytic anæmia, but the blood changes are inconstant. Spherocytosis and increased fragility may be present. The red cells may be normocytic or macrocytic. The reticulocytes are usually increased. The indirect van den Bergh test is positive, and excess of urobilinogen is found in the fæces. Hæmolytic crises may occur. The urine contains urobilin. Gall-stones occur as a complication.

Treatment. Splenectomy will often effect a cure, but should not be performed until any possible cause of the disease has been treated and the effect of corticosteroids determined. Blood transfusion is usually required before the operation, but it must only be given after very careful cross-matching followed by the Coombs test for sensitisation. After splenectomy the Coombs test usually remains positive.

Sickle-cell Anæmia

(*Drepanocytic Anæmia*)

Definition. A severe anæmia, in which the red cells, when deprived of oxygen, assume an elongated or sickle shape.

Etiology. Sickle-cell anæmia occurs chiefly in negroes of West Africa and North America. Both sexes are affected and there is a familial incidence, the sickle-cell trait being transmitted as a Mendelian dominant. The patient is usually under 20 years of age.

Pathology. The liver is usually enlarged, and there is hypertrophy of bone marrow and lymphoid tissue. The spleen is enlarged early in this disease, owing to congestion, but later, as the result of siderofibrosis, it is small. The "sickling" depends upon the partial oxygen pressure. The deformity of the red cell is due to the hæmoglobin not remaining in solution. The hæmoglobin is abnormal and is known as hæmoglobin S. There is replacement of glutamic acid in the β chain of normal adult hæmoglobin by valine. Abnormal hæmoglobin C and D are found in some cases. If the arm or finger is compressed, in order to reduce the oxygen supply, immediately before the blood is taken, the number of sickle-cells seen in the direct film may be 90%. The sickle-cell trait results from an individual receiving hæmoglobin S from one parent only

Prognosis. Death is to be expected in less than a year unless there is some cause which can be removed.

Treatment. The effect of vitamin B₁₂ treatment in this disease is usually disappointing. Iron and arsenic are without avail. A blood transfusion produces only temporary improvement, but repeated drip transfusions may keep the patient alive for several years. Concentrated suspensions of fresh red cells are preferable to whole blood, as they are required less frequently. When the hæmoglobin falls to 55% (8.1 G. Hb./100 ml.), a transfusion should be given sufficient to raise the hæmoglobin to over 80% (11.0 G. Hb./100 ml.). Prednisone may also be given to diminish the tendency to bleeding from the skin and mucous membranes, at first 50 to 100 mg. a day for 4 weeks followed by a maintenance dose of 15 mg. daily. To prevent menorrhagia fluoxymesterone (Ultandren), a non-virilising androgen, may be given, 5 mg. tab. daily, reduced to 2 mg. daily. Very occasionally splenectomy is successful; more often the patient dies within a few days of the operation.

Agranulocytosis

(*Agranulocytic angina. Granulocytopenia. Malignant neutropenia*)

Definition. A disease characterised by a marked diminution in the number of granulocytes in the blood (neutropenia), with ulceration in the mouth, rectum or vagina.

Etiology. A few cases are of the acute idiopathic type, associated with idiopathic aplastic anaemia. The majority are due to substances which poison the bone marrow. Amidopyrine and some sulphonamides are particularly dangerous, and a small dose of either may sensitise the patient. Noxious substances thus include amidopyrine, Novalgin, or barbiturates containing amidopyrine such as Allonal, Cibalgin and Veramon. Dinitrophenol, used for slimming, benzol, bismuth and gold salts, thiouracil, atomic bomb radiations, neoarsphenamine, carbinazole (Neo-Mercazole), phenylbutazone (Butazolidin), Tridione, Diamox, chlorpromazine, and chloramphenicol may also cause agranulocytosis. Very severe infections may also cause agranulocytosis. These include osteomyelitis, sinusitis, transverse sinus thrombosis, septicæmia and liver abscess. It is possible that in cases associated with infection agranulocytosis is the primary change and this allows the infection to develop unchecked. Hypersplenism may also cause agranulocytosis, possibly through an exaggerated inhibitory effect of a splenic hormone on the bone marrow, possibly because of overdestruction of white cells by the spleen. Agranulocytosis may result from irradiation and from the use of radioactive phosphorus, or be a part of the blood picture in aplastic anaemia, or aleukæmic leukaemia. *Predisposing causes:* 1. Age: Usually adults. 2. Sex: Females predominate.

Pathology. There is a marked diminution or absence of myeloid cells (aplastic type) or of granulocytes (maturation type) in the bone marrow. No leucocidal substance is present in the blood.

Clinical Findings. The disease may have an acute onset with sore throat, dysphagia, headache, shivering, generalised myalgic pains and

poikilocytosis and many normoblasts. Hb. 30 to 60% (4.4 to 8.9 G. Hb./100 ml.) C.I. low. Fragility normal. White cells, 15,000 to 50,000 per c.mm. A few myeloid cells are seen in severe cases. Platelets normal. Indirect van den Bergh positive. X-ray examination shows changes in the skull, the long bones and the small bones of the hands and feet. There is rarefaction and trabeculation of the long bones. Radiating spicules are seen in the lateral view of the skull.

Differential Diagnosis. Conditions which require exclusion are acholuric jaundice, sickle-cell anæmia, leukæmia and syphilis.

Course and Complications. The disease is steadily progressive.

Prognosis. Death usually occurs before the age of 10.

Treatment. The administration of iron is not usually of any value. Splenectomy is occasionally advised.

ANÆMIAS DUE TO INHIBITION OF BONE MARROW FUNCTION

Aplastic Anæmia

Definition. A severe anæmia, closely resembling pernicious anæmia, but the course is not interrupted by remissions.

Etiology. Aplastic anæmia is classified as a primary anæmia, as in many cases no cause can be discovered. In some cases it is due to exposure to atomic bomb explosion, to X-rays or radium, to carbon tetrachloride, or to poisoning with benzol, gold, phenylhydrazine, the sulphonamides, or mustard gas. It may also occur as a terminal phase of untreated pernicious anæmia, or of polycythæmia rubra, or be due to replacement of bone marrow by sarcomatous or carcinomatous tumours, or it may complicate acute infections especially in children, such as influenza and diphtheria.

Pathology. There is marked aplasia of the marrow of the long bones, the normal marrow being replaced by fat, and iron is not deposited in the internal organs.

Clinical Findings. The patient is usually a young adult of either sex, who notices weakness, pallor, dyspnoea and palpitations as in pernicious anæmia. The skin may have a yellow tinge. Purpura or hæmorrhages from mucous membranes, or from the uterus, may occur. The blood: Red cells, 0.5 to 1.5 million per c.mm. The cells are generally of normal appearance. There are usually no reticulocytes. Hb. 10 to 30% (1.3 to 4.4 G. Hb./100 ml.) C.I., 0.9 to 1. White cells, 1,000 to 2,000 per c.mm. There is a relative lymphocytosis (up to 60%). No myelocytes are seen. Platelets are diminished. Bone marrow removed by sternal trephine is usually hypoplastic showing a lack of mature cells; occasionally it is hyperplastic with many primitive cells. Achlorhydria is not present. The van den Bergh reaction is negative.

Differential Diagnosis. The severe nature of the anæmia is apparent. The blood count distinguishes it from pernicious anæmia and agranulocytosis. In aleukæmic leukæmia lymphoblasts or myeloblasts are present, and examination of the bone marrow serves to differentiate.

Course and Complications. The course is steadily progressive.

may also be helpful, and 200 mg. should be injected intravenously daily for a week. Fluids up to 5 pints (8 litres) should be taken daily. The local necrotic areas should be appropriately treated. Thus the mouth should be sprayed before feeding with cinchocain. hydrochlorid. B.P. (Nupercaine) 1%, in glycerin 75% and water 24%, if pain prevents swallowing. Penicillin lozenges may be taken, as described above, or the mouth swabbed after feeds with hydrogen peroxide (10 vols.) diluted with an equal quantity of water, followed by a swabbing with a citric acid solution of 10 gr. (0.6 G.) to 1 fl. oz. (30 ml.). In cases of hyperplenism splenectomy is usually advisable.

THE LEUKÆMIAS

Definition. Progressive diseases of the hæmopoietic system, characterised by an increase in the white cells and their precursors in the blood and changes in the myeloid or lymphoid tissues of the body.

Etiology. It is probable that the changes are of the nature of a new growth and result in some cases from exposure to X-rays, to radiations from atomic-bomb explosions, or in association with phenylbutazone (Butazolidin) treatment. Although viruses have been found associated with leukæmia there is no proof that a virus is the cause of the disease. During the last 12 years there has been an increase in the incidence of acute leukæmia.

Varieties. Leukæmia may be acute or chronic, and is subdivided further into acute lymphatic leukæmia (lymphadenosis), acute myeloid leukæmia (myelosis), acute monocytic (histiocytic) leukæmia, chloroma, chronic lymphatic leukæmia, and chronic myeloid leukæmia.

Pathology. The types of white cells which are seen in the blood in the leukæmias are largely embryonic, such as myelocytes, myeloblasts, lymphoblasts, etc. The only way to learn to recognise these cells is by having them demonstrated in blood films under the microscope, and a detailed description will not therefore be given (see Fig. 49).

Acute Lymphatic, Acute Myeloid and Acute Monocytic Leukæmias

Clinically it is impossible to distinguish between these diseases, apart from the blood examinations. They are comparatively rare.

Pathology. *Acute Lymphatic Leukæmia.* There is hyperplasia of lymphatic tissue throughout the body, with enlargement of the lymph nodes and infiltration of the spleen, liver and bone marrow with lymphocytic cells.

Acute Myeloid Leukæmia. The lymph nodes are enlarged to a varying degree, and the spleen, liver and bone marrow are infiltrated with myelocytes and promyelocytes.

Acute Monocytic Leukæmia. The spleen, liver, bone marrow and lymph nodes are infiltrated with embryonic monocytes (histiocytes).

In all varieties hæmorrhages may be found in such organs as the stomach, intestines, lungs, brain, kidneys, into the buccal mucous membrane and under the skin. Chromosome changes have been found in acute leukæmia.

fever. In other cases the disease begins insidiously during gold or sulphonamide treatment. Chronic or recurrent cases also occur in which the white cells from time to time fall below 4,000 per c.mm., owing to a reduction of granulocytes, with accompanying symptoms of ill-health and a liability to septic infections.

On Examination: The temperature is raised to about 102° F. (38.9° C.). Ulceration is seen in the mouth, in such sites as the tonsils, pharynx or tongue. The cervical lymph nodes are in some cases enlarged and the spleen may be just palpable. There may be jaundice and necrotic lesions in the skin, rectum or vagina. There is no tendency to bleeding from mucous membranes. Meningitic symptoms may occur, the cerebrospinal fluid showing a paretic type of Lange reaction. The urine: A trace of protein is usually present. The blood: There is a leucopenia, due to the marked diminution of the granulocytes. A typical count is as follows: White cells, 1,000 per c.mm. Polymorphonuclears 4%, mononuclears 16%, lymphocytes 80%. No immature white cells are seen. The red cell and platelet count are normal, or there may be a slight anaemia.

Differential Diagnosis. The throat lesion may suggest Vincent's angina or diphtheria. These are excluded by examination of the throat swabs and by the blood count. The leucopenia with relative lymphocytosis is differentiated from aleukæmic lymphæmia by the absence of immature white cells. Monocytic angina somewhat resembles agranulocytosis. In the former the white cells show a high proportion of monocytes (up to 80%). In aplastic anaemia the red cell count is low. Periodic neutropenia may occur, characterised clinically by recurrent oral ulceration.

Course and Complications. In acute untreated cases the course is usually rapidly progressive to a fatal issue. Complications include bronchopneumonia and jaundice.

Prognosis. The prognosis has been much improved by the use of penicillin except in the acute idiopathic type and in severe secondary cases. The response of the maturation type is more favourable than that of the aplastic type.

Treatment. Prophylactic. Amidopyrine is a dangerous drug and should not be prescribed. There appears to be no justifiable reason for the use of gold salts. Sulphonamides should not be given for longer than 7 to 10 days and drug fever is an indication for their immediate discontinuance.

Curative. No definite curative treatment is known. A line of treatment which has been successful in some cases is a course of penicillin. This is based on the hope that if the risk of secondary infection, which is usually the cause of death in agranulocytosis, is removed or minimised by the penicillin, the bone marrow will recover its power of forming granulocytes, and, once the noxious agent is removed, a cure will result. 800,000 units of a procaine penicillin should be injected every 12 hours for about a week, and if there are mouth lesions, a penicillin lozenge may be sucked every hour for 8 doses. Tetracycline (Achromycin) should be given by mouth, 250 mg. capsule, 4 times daily. Vitamin B₆ (pyridoxine)

may also be helpful, and 200 mg. should be injected intravenously daily for a week. Fluids up to 5 pints (3 litres) should be taken daily. The local necrotic areas should be appropriately treated. Thus the mouth should be sprayed before feeding with cinchocain. hydrochlorid. B.P. (Nupercaine) 1%, in glycerin 75% and water 24%, if pain prevents swallowing. Penicillin lozenges may be taken, as described above, or the mouth swabbed after feeds with hydrogen peroxide (10 vols.) diluted with an equal quantity of water, followed by a swabbing with a citric acid solution of 10 gr. (0.8 G.) to 1 fl. oz. (30 ml.). In cases of hyperplenism splenectomy is usually advisable.

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Acute Monocytic Leukæmia. The spleen, liver, bone marrow and lymph nodes are infiltrated with embryonic monocytes (histiocytes).

In all varieties hæmorrhages may be found in such organs as the stomach, intestines, lungs, brain, kidneys, into the buccal mucous membrane and under the skin. Chromosome changes have been found in acute leukæmia.

Clinical Findings. The patient is usually a male under the age of 20. Females are only affected half as frequently. The onset usually resembles a feverish attack or chill, or a hæmorrhage from the mouth, rectum, vagina or other site may be the initial symptom. Intractable hæmorrhage after dental extraction may be the first indication of the disease. The patient may complain of pain in the bones.

On Examination : The patient looks pale and ill, and purpuric spots or larger ecchymoses may be seen in the skin. The temperature is irregular, between 99° F., (37·2° C.) and 101° F., (38·3° C.) or higher. The pulse is proportionately rapid. Necrotic lesions may be seen in the mouth or fauces. The liver or spleen may be just palpable and the lymph nodes in the neck, axillæ or groins enlarged. In acute myeloid leukæmia there may be tenderness on tapping over the sternum. A mediastinal type occurs, in which pressure signs point to a mediastinal tumour; this is confirmed by X-ray examination. The blood count : (a) *Acute lymphatic leukæmia*. Red cells, 3 millions per c.mm. or less. Hb. 50% (7·4 G. Hb./100 ml.) or less. C.I. 0·8 to 0·9. There may be anisocytosis with a few megaloblasts or normoblasts. Platelets, usually reduced. White cells, 10,000 to 100,000 per c.mm. The majority of cells are non-granular. Polymorphonuclears 2%, lymphocytes—some with "smear" nuclei and lymphoblasts 98%. The lymphocytes may be small or large. The oxidase reaction is negative as the cells are agranular. (b) *Acute myeloid leukæmia* : Red cells as above, but often megalocytes and some megaloblasts are seen. White cells, 20,000 to 200,000 per c.mm. Polymorphonuclears 2 to 4%. Lymphocytes 3%. Myeloblasts and myelocytes 93%. The myeloblastic cells give the oxidase reaction as they are granular. (c) *Acute monocytic leukæmia*. Red cells as above. White cells, 50,000 per c.mm. Monocytes 87%. Polymorphonuclears 4%. Lymphocytes 9%. Later a few monoblasts may be found. In some cases the blood changes are aleukæmic in type. Sternal puncture shows the bone marrow very cellular, 70 to 99% of the cells being primitive white cells of either the myeloid or lymphatic series.

Differential Diagnosis. The onset of the illness may suggest a feverish cold or influenza. Hæmorrhage may point to a lesion of the lungs, stomach or intestines. The enlarged lymph nodes, fever and palpable spleen or liver occur also in glandular fever. The continuous fever may arouse suspicions of bacterial endocarditis, tuberculosis, or typhoid fever. The hæmorrhages in the skin or mucous membranes might be due to purpura or scurvy. The diagnosis is established by the blood count and examination of the bone marrow; attention should be paid to the changes also present in the red cells, which are a distinctive feature of acute leukæmia as opposed to glandular fever.

Course and Complications. The course usually is rapid, but spontaneous remissions may occur. Subacute cases occur characterised by the bone marrow findings of acute leukæmia, the formation of tumours in the mediastinum, abdomen or bones (see chloroma) and in which there is little or no fever, hæmorrhages are unusual, and the fatal issue may be postponed for about six months. Complications include the hæmorrhages into various sites and leukæmic retinitis.

Prognosis. The outlook is hopeless ; death usually occurs in a few days to a few weeks from the onset. A cerebral hæmorrhage may cause rapid death.

Treatment. In acute monocytic leukæmia a remission may sometimes follow the administration of 6-mercaptopurine 2.5 mg./kg. body weight. Prednisone can be given by mouth in doses of 5 to 20 mg. every 6 hours. Necrotic mouth lesions should be treated as described under agranulocytosis. X-ray treatment may cause a temporary disappearance or diminution of a mediastinal mass.

Acute Leukæmia in Children

In the acute leukæmia of children a remission may often be obtained by administering prednisolone in doses of 3 mg./kg. body weight daily. When the remission has been obtained the child is given 6-mercaptopurine (Puri-Nethol) in doses of 2.5 mg./kg. body weight daily. This is put up in 50 mg. tablets. After 3 months treatment methotextrate is given, 2.5 mg. daily for 3 months, alternating with 3 months courses of mercaptopurine. During the remission period the children are well and happy, but, alas, the disease is fatal. The remission may last for 2 or 3 years. There is a higher remission rate in lymphoblastic than in myelocytic leukæmia.

Chloroma

Definition. A variety of subacute myeloid or rarely lymphatic leukæmia accompanied by the formation of tumours in the subperiosteal tissues and elsewhere.

Etiology. The cause is unknown. Chloroma occurs usually in male children.

Pathology. Greenish nodules of lymphoid tissue are found in all the organs of the body, except the brain, and they occur under the periosteum, and in the bone marrow, especially in the orbit, skull, long bones, vertebræ, ribs and sternum. The green colour, the cause of which is unknown, fades on exposure to air.

Clinical Findings. The symptoms may resemble those of acute leukæmia. Early nervous symptoms, such as pains in the back and legs and inability to walk, may be the first indication of ill health. In addition, an orbital tumour may cause protrusion of the eye, and swellings in the skull may result in facial paralysis, deafness or blindness. A sternal swelling may be apparent. The blood count resembles that of acute myeloid or rarely lymphatic leukæmia.

Prognosis. Death occurs rapidly, usually in 4 to 8 months from diagnosis.

Treatment. There is no cure and treatment is only symptomatic.

infiltrated with lymphocytes. The bone marrow of the long bones is grey and shows lymphoid metaplasia.

Clinical Findings. The patient is usually a male of middle age. He complains of weakness, pruritus, bone pains, swelling of the tonsils, enlargement of the lymph nodes in the neck or elsewhere, or of swelling of the abdomen, caused by the spleen.

On Examination : Groups of enlarged lymph nodes may be seen and felt in the neck, axillæ, elbows and groins. They are soft early in the disease, but later are hard ; they are not tender. The skin is freely movable over them. In some instances there is a generalised cutaneous lesion resembling exfoliative dermatitis, and small nodules may be felt in the skin (leukæmia cutis). The skin in certain areas may be slightly red and thickened owing to lymphatic hyperplasia. The tonsils may be enlarged owing to lymphatic infiltration. The spleen and liver are usually enlarged, often to a considerable degree. There is frequently a slight but irregular fever. Cranial nerve palsy has been noted in some cases, the VI and VII nerves being especially liable to be affected. The blood count : Red cells, 8 millions per c.mm. or less. Hb. 60% (8.9 G. Hb./100 ml.) or less. C.I. 0.6. White cells, about 90,000 per c.mm. Polymorphonuclears 2 to 8%. Small lymphocytes 92%. Large lymphocytes 2%. An occasional lymphoblast. The bone marrow obtained by sternal puncture shows 40 to 90% of the cells to be lymphocytes. The basal metabolic rate is raised.

Differential Diagnosis. The disease must be differentiated from other causes of chronic lymph node and splenic enlargement, such as myeloid leukæmia, Hodgkin's disease, tuberculosis, syphilis, etc. Enlargement of the mediastinal lymph nodes may produce cough simulating whooping cough. The blood count establishes the diagnosis. There is, however, a variety of chronic leukæmia in which the total number of white cells is not increased, but the differential count is similar to that given above. This is called *aleukæmic lymphæmia*. Examination of the bone marrow is of great help in establishing the diagnosis.

Course and Complications. The disease usually pursues a chronic course of several years' duration. The number of large lymphocytes and lymphoblasts in the blood often increases, indicating the probability of an acute termination. The presence of myelocytes may be indicative of bone marrow stimulation. Complications include : Venous thrombosis and rarely hæmorrhages in the middle ear, retina or stomach.

Prognosis. Death usually occurs in from 3 to 5 years from the date of diagnosis.

Treatment. When there is lymphocytosis but the lymph nodes are not markedly enlarged and there is little anæmia, special methods of treatment are best avoided. X-rays are usually effective in reducing the size of lymph node masses, but the total number of white cells in the blood is seldom reduced, unless X-ray treatment is given to the spleen. Blood transfusion is helpful in cases of anæmia. Radioactive phosphorus (P^{32}) can also be given. The dose is 6 millicuries intravenously, repeated in 6 or 8 weeks, if necessary. It does not produce radiation sickness. The initial dose by mouth of P^{32} is 2 millicuries

followed by 1 millicurie once or twice a week for 4 to 5 doses, and subsequently every week or two weeks until the white cell count falls to about 30,000 (see also p. 551). Chlorambucil (Leukeran) has been favourably reported on. The dose is 0.1 to 0.2 mg./kg. body weight by mouth for 3 to 6 weeks according to its effect on the white cells. When hæmolysis occurs prednisone may produce a temporary improvement. Splenectomy is sometimes recommended, if there is great pain and discomfort from the enlarged spleen, or if there is severe hæmolysis and thrombocytopenia.

Chronic Myeloid Leukæmia

(Chronic Granulocytic Leukæmia)

Pathology. The clotted blood may have a greenish-white colour. The lymph nodes: These are only slightly affected. The mesenteric lymph nodes may be enlarged. The spleen is much enlarged and may weigh as much as 18 lbs. (8 kg.), the normal weight is 5 to 6 oz. (150 to 180 G.). There is perisplenitis. It is firm on section and whitish nodules are studded in its texture. There is myeloid metaplasia of the spleen substance and atrophy of the Malpighian corpuscles. The liver is enlarged, and areas resembling multiple abscesses are seen, consisting of myeloid metaplasia around the intralobular capillaries. Portions of the ileum may be infiltrated with myeloblasts resulting in ulceration and perforation. The bone marrow: This is greyish-red, and shows proliferation especially of myeloblasts. The kidneys show leukæmic infiltration.

(usually neutrophil, a few eosinophil and basophil). Premyelocytes and myeloblasts 3%. In *eosinophilic leukæmia*, the leucocytes are chiefly mature eosinophil cells, with larger granules than are present in normal eosinophils, usually eosinophil myelocytes, up to 2%, are present. The bone marrow obtained by sternal puncture shows an increase in myeloblasts, premyelocytes and myelocytes. *Aleukæmic leukæmia*: This resembles aleukæmic lymphæmia mentioned on p. 540, but in this condition the abnormal white cells are of the granular type (myeloblasts and myelocytes) although the total white cell count is not increased. The diagnosis can be established by examination of the bone marrow.

Differential Diagnosis. Myeloid leukæmia must be differentiated from other causes of anæmia, especially pernicious anæmia, and from other conditions associated with enlargement of the spleen. Examination of the blood establishes the diagnosis.

Course and Complications. The course is usually prolonged for 4 or 5 years or more. Crises may occur, in which the patient becomes more ill, with an increase in the myeloblasts. Towards the end the disease may pursue a very rapid course. Remissions do not occur spontaneously but may result from secondary infections or from treatment. Complications include: Venous thrombosis, hæmorrhages in internal organs and muscles, labyrinthine involvement causing deafness and vertigo, and leukæmic retinitis.

Prognosis. The disease is fatal in about three years.

Treatment. Various forms of treatment may be given. These include irradiation, either by X-rays or by radioactive phosphorus (P^{32}). The latter does not cause radiation sickness and is about as effective as X-rays. Nitrogen mustard (mustine hydrochloride) is given intravenously diluted with saline, 0.1 mg./kg. body weight for 4 days or uracil mustard may be given by mouth. It is liable to cause vomiting and rise of temperature. Busulphan (Myleran) (1 : 4-dimethanesulphonyl-oxybutane) has the advantage that it is given by mouth in tablets of 2 mg., or 0.5 mg. There are no side effects. It reduces the size of the spleen and liver, lowers the white cell count, raises the hæmoglobin level and relieves the patient of his symptoms. The standard dose is 0.06 mg./kg. body weight daily, which is about 4 mg. for an adult. The treatment usually lasts for 3 to 7 months, as determined by the blood count. A second course is given when the symptoms recur, usually after an interval of 5 to 18 months. It is not believed to be effective indefinitely.

Hodgkin's Disease

(*Lymphadenoma. Lymphogranuloma*)

Definition. A fatal disease characterised by enlargement of lymph nodes with the formation of lymphogranulomatous tissue in the spleen and elsewhere.

Etiology. It is usually considered that Hodgkin's disease is either an infective granuloma of unknown etiology, or a malignant neoplasm.

fissure. Enlarged abdominal lymph nodes cannot usually be felt. Pressure on the spinal medulla (cord) or spinal roots may result in sensory changes in the extremities, or some degree of weakness or paraplegia. The skin is usually pale, but pigmentation may be seen apart from that resulting from the therapeutic use of arsenic, especially if the abdominal lymph nodes are involved. Other cutaneous lesions include erythematæ, generalised exfoliative dermatitis, and rarely small nodules of lympho-granulomatous tissue may be felt under the skin. Ulceration may occur in the skin lesions. Herpes zoster is usually associated with arsenical treatment, but it may occur apart from this and be generalised.

The Relapsing Type (Pel-Ebstein Syndrome). As mentioned above, there is usually slight irregularity of temperature in all cases of Hodgkin's disease, but periodical waves may occur with apyrexial intervals. The pyrexial periods usually last for 5 or 6 days and recur at intervals of 15 to 30 days, the span, which is the distance between the crests of the successive waves, being fairly constant in each case. During the fever the patient feels more ill, may vomit and the spleen and lymph nodes often enlarge. In the intervals the patient feels comparatively well and may gain weight. The blood: The serum gamma-globulin level is raised. In some cases there is a leucocytosis of 20,000 per c.mm. or more, even in the afebrile periods, with an excess of polymorphonuclears, reduction of lymphocytes and slight excess of monocytes. In other cases there is leucopenia. In acute cases the number of eosinophils may be much increased, and they have large granules. When the bone marrow is involved myelocytes and myeloblasts appear in the circulation. The red cell count may rarely show a hæmolytic anæmia, but in some cases a macrocytic anæmia has been described, closely resembling pernicious anæmia, but with a normal or increased fragility of the red cells.

Differential Diagnosis. This involves a consideration of other causes of lymph node and splenic enlargement, of mediastinal pressure, of ascites and jaundice, and of irregular or periodical pyrexia. Enlarged lymph nodes may result from tuberculosis, leukaemia, lymphosarcoma, syphilis, sepsis and glandular fever. Mediastinal pressure may be due to a new growth, aneurysm or enlarged lymph nodes from several causes. Unexplained pyrexia may be due to tuberculosis, bacterial endocarditis, enterica group infections, brucella infections, malaria, etc. In all cases the blood must be examined, and if possible a superficial lymph node should be removed and examined microscopically. Often, however, the pathological report is indefinite.

Course and Complications. Certain types are described according to the course pursued. 1. Chronic Hodgkin's disease: Here the disease is progressive, but interrupted by remissions. Life may be prolonged for four or five years. 2. The relapsing type: Described above. 3. The acute type (Hodgkin's sarcoma), in which the disease is rapidly fatal. Complications result from mediastinal pressure, intercurrent infection, amyloid degeneration or tuberculous infection.

Prognosis. The disease is usually fatal. Some radiotherapists claim that the localised form can be cured in about 40% of cases by X-ray treatment.

Treatment. Adequate rest, fresh air and nourishing food should be ensured. Arsenic usually causes a temporary improvement. X-ray treatment is still the standard form of treatment. It usually causes a temporary remission, the lymph nodes diminishing in size or disappearing. With relapse it is usual for other lymph nodes to swell. Treatment with radioactive metals, such as phosphorus, has not met with more success than radiotherapy, possibly because so much radioactive phosphorus would have to be given as to cause bone marrow damage. Nitrogen mustard (mustine hydrochloride) may give temporary relief, especially in generalised cases. The dose is 0.1 mg./kg. body weight injected by a saline drip intravenously on alternate days for 3 to 6 injections. There are often general toxic reactions, such as rigors or vomiting, within a few hours of the injection. A second course must not be given at less than 8 weeks' interval. The blood must be examined to exclude leucopenia or thrombocytopenia before a second course is given. Alternatively, TEM (triethylene-melanine) may be given by mouth, in the form of 2.5 mg. tab., 1 to 2 daily one hour before breakfast for 3 to 4 doses. This may be repeated at intervals of 4 to 6 weeks.

Splenic Anæmia

(Banti's Disease)

Definition. A disease characterised by anæmia, leucopenia, enlargement of the spleen, cirrhosis of the liver and gastro-intestinal hæmorrhages.

Etiology. The cause is unknown. Some authorities differentiate splenic anæmia from Banti's disease, maintaining that cirrhosis of the liver does not occur in the former; others deny the concept that splenic anæmia or Banti's disease is a primary disease of the spleen. They believe that the condition is one of congestive splenomegaly and that the pathological findings are always due to mechanical obstruction of blood flow in the portal system, the commonest cause being hepatic cirrhosis, and in other cases there is extrahepatic portal obstruction due to thrombosis, trauma or a pancreatic cyst.

Pathology. The spleen is enlarged and smooth. It is firm on section, fibrotic, and the sinuses are much dilated. Gandy-Gamma nodules result from periarterial hæmorrhages, in which fibrotic nodules form containing crystalline or amorphous iron pigments. The liver may be slightly enlarged, or small and cirrhotic. The splenic veins are seen to be tortuous and dilated, at splenectomy. Phlebitis is seen in some cases in the splenic and portal veins, and the œsophageal and gastric tributaries are dilated.

Clinical Findings. The patient is usually a young adult male. The disease is rare in children and after middle age. The onset is insidious. The first symptoms of ill health may be lassitude, pallor, epistaxis, hæmatemesis, melæna, or enlargement of the abdomen. Banti's disease is described as passing through three stages:—*The first stage*: There is anæmia, and enlargement of the spleen, but no jaundice.

The spleen may weigh as much as 25 oz. (750 G.), and yet not be palpable. The blood : There is a hypochromic anæmia with a low colour index. The white cells show a leucopenia with a relative lymphocytosis. The fragility of the red cells is normal. The blood platelets may be increased or diminished, constituting a thrombocythæmic or a thrombocytopenic variety of the disease. *The second stage* : After 2 or 8 years the liver enlarges and there is slight jaundice. *The third stage* : In another 2 or 8 years the liver shrinks and ascites appears. It must be understood that all cases do not pass through these stages. Severe hæmorrhage may occur from the œsophagus, stomach, intestines, kidneys or nose, and purpura may be seen. The lymph nodes do not enlarge.

Differential Diagnosis. In establishing the diagnosis it is necessary to consider other causes of severe anæmia, of epistaxis and internal hæmorrhages, of tumours in the left hypochondrium, and of enlargement of the liver and spleen, or of ascites. The blood count demonstrates the anæmia. The tumour in the left hypochondrium presents the characteristic features of an enlarged spleen. A gastric ulcer and carcinoma of the stomach or colon may present difficulties, but an opaque meal usually will exclude these lesions. In acholuric jaundice the fragility of the red cells is increased, and bleeding from mucous surfaces does not usually occur. The supporters of the view that Banti's disease is a separate entity state that in cirrhosis of the liver the spleen is not usually enlarged before the liver enlarges, and the splenic enlargement in cirrhosis is not usually as marked as in Banti's disease. With primary thrombosis of the portal or splenic vein there is usually leucocytosis, and the abdominal symptoms are more acute.

Course and Complications. The course is slowly progressive, as described above, although sudden death may occur from hæmorrhage. Intercurrent infections may ensue.

Prognosis. This is very grave, if untreated the disease is almost always fatal.

Treatment. Iron should be given in adequate doses, such as ferri et ammon. cit. 30 gr. (2 G.) t.i.d., for eight weeks. This may be combined with X-ray treatment to the spleen. In cases of hæmorrhage a drip transfusion may save the patient's life, although usually only temporarily, as recurrences are very liable to occur at intervals of months or years. Various types of portacaval anastomotic operations may be successful in lowering portal hypertension and preventing recurrences of hæmorrhage, but they are often technically impossible. Splenectomy is of doubtful value and the operation is not devoid of risk. The occurrence of post-operative thrombosis in cases with a high platelet count has been reduced by the use of anticoagulants. Further severe hæmorrhages are liable to occur after splenectomy in at least 50% of patients who suffered from hæmorrhage before the operation.

THE LIPIDOSES

Under this heading are classified three diseases characterised by a disturbance of lipid metabolism.

Gaucher's Disease
(*Cerebroside Lipidosis*)

Definition. A rare disease characterised by enlargement of the spleen, the presence of Gaucher cells in the spleen and other organs, and a tendency to a familial incidence.

Etiology. The cause is unknown. It is regarded as an inborn error of lipid metabolism. The tendency to the disease is thought to be transmitted as a simple dominant trait. It may remain sub-clinical, the individual then acting as a carrier, although able to transmit the clinical disease. In succeeding generations it is transmitted at an earlier age until the infantile type is reached, with lesions in the central nervous system, which is rapidly fatal.

Pathology. The spleen is enlarged and the capsule thickened. Infarcts may be seen on section. Microscopical examination reveals the typical Gaucher cells. They are enlarged reticulum cells, derived from the reticulo-endothelial system containing a lipid, kersin. Similar cells may be found in the liver, mesenteric lymph nodes and bone marrow, and in the infantile type in the brain and the lungs.

Clinical Findings. The onset is in infancy, or in childhood or later, and females of the Jewish race are especially affected. The patient may complain of abdominal swelling or discomfort, of pains in the muscles and bones, and of a tendency to bleeding from the nose or gums.

On Examination : The enlarged spleen is usually found on routine examination. The liver may be just palpable or considerably enlarged. There is often pigmentation of exposed areas of the skin, and symmetrical pigmentation of the legs in stripes ; there may be slight jaundice. A brown-yellow fatty thickening (pinguecula) may be seen on the conjunctivæ. X-ray examination of the bones, especially of the vertebræ and femurs, may show decalcification, sclerosis, bone absorption, deformities and rarely the cystic decalcification similar to that met with in essential xanthomatosis. In the early stages the lower end of the femurs may show a characteristic Erlenmeyer flask deformity, due to flaring of the distal part of the femur, the cortex being thinned and distended. The blood : There may be some degree of hypochromic anæmia and leucopenia. The blood platelets are slightly diminished. Later, hypersplenism may develop, with hæmolytic anæmia, leucopenia and thrombocytopenia. The blood cholesterol figures are normal. Examination of the bone marrow obtained by sternal puncture shows typical Gaucher cells.

Differential Diagnosis. The diagnosis can only be established with certainty during life by splenic, sternal or liver puncture, and the discovery of Gaucher cells in the material removed. The familial incidence, age of onset, enlargement of the spleen, chronic course and the usual maintenance of fair health suggest the diagnosis.

Course and Complications. The course is prolonged, and the patient usually survives for many years. In the later stages the liver may be considerably enlarged.

Prognosis. The acute infantile variety is usually fatal within 6 months. The adult type tends to be chronic. Subclinical cases, in which Gaucher cells are found in the bone marrow, have a normal expectation of life.

Treatment. Splenectomy often relieves the symptoms and corrects the blood changes due to hypersplenism, but has no effect on the course of the disease. This also applies to X-ray treatment. The bone pains may be relieved by X-ray treatment.

Niemann-Pick Disease

(*Histiocytic Sphingomyelinosis*)

This disease affects infants usually of the Jewish race. It is characterised by enlargement of the spleen, liver and superficial lymph nodes. The face has a mongoloid expression. Black spots may be seen on the tongue. The Niemann-Pick foam cells are present in various organs of the body including the central nervous system. There is an accumulation and retention of diaminophosphatide and sphingomyelin. The skin is pigmented on exposed areas and the blood shows a hypochromic anemia, with lipid vacuoles in the white cells. The blood cholesterol is slightly raised in a few cases. The blood serum does not show an increase of sphingomyelin. Cells obtained by sternal or splenic puncture show a typical foam appearance. The disease appears to be related to the Tay-Sachs syndrome. It is usually fatal before the age of two years and no cure is known.

Hand-Schüller-Christian Disease

(*Xanthomatosis of Bones*)

This is another disorder of lipid metabolism (cholesterol esters), which usually affects males. Accumulations of lipid material with formation of granulation tissue or fibrotic areas containing cholesterol crystals occur in bones, especially in the membrane bones of the skull. Xanthoma nodules also occur in long bones, which have a cyst-like appearance in X-ray films. The spleen, liver, kidneys and lymph nodes are often enlarged. The total blood cholesterol is normal or a high normal. The disease shows itself in early childhood and is characterised by bony softening, exophthalmos and diabetes insipidus. Granulation tissue involving the orbit results in exophthalmos and when it invades the sella turcica diabetes insipidus results. Small xanthomatous nodules, resembling miliary tuberculosis, may be seen on radiological examination of the lungs. Rarely the disease first shows itself in adult life, the bony changes being chiefly in the long bones, and exophthalmos is not necessarily present.

Enlargement of the Spleen

The causes of enlargement of the spleen may be classified as follows :

1. *Protozoal infections and parasitic worms*, such as malaria, kala-azar, and schistosomiasis.
2. *Bacterial infections*, such as enterica

group organisms, streptococci in septicæmia, etc. 3. *Hæmopoietic and reticulo-endothelial diseases*, such as pernicious anæmia, leukæmia, Hodgkin's disease, Gaucher's splenomegaly, acholuric jaundice, polycythæmia rubra, splenic neutropenia, etc. 4. *Specific infective granulomata*, as in tuberculosis and syphilis. 5. *Deficiency diseases*, such as rickets. 6. *Vascular disturbances*, such as infarction, passive hyperæmia from torsion of the pedicle, thrombosis of the splenic vein, cirrhosis hepatis, pressure of enlarged lymph nodes on the portal vein, and very rarely congestion due to heart failure. 7. *Cysts*. These may be classified as parasitic, i.e. a hydatid cyst, and non-parasitic. The latter are subdivided into true and false cysts. True cysts may be dermoid, hæmangioma, lymphangioma, endothelioma (serous), or due to polycystic disease. False cysts may result from trauma, hæmorrhage, malaria, infarcts or degeneration. 8. *Tumours*, such as primary or secondary sarcoma or secondary carcinoma. The spleen may be invaded by a direct extension of a carcinoma of the stomach or pancreas. Simple tumours are rare, such as a fibroma, lymphangioma and hæmangioma. 9. *Abscess*, such as a septic infarct. 10. *Degeneration*, as in amyloid disease.

The signs of enlargement of the spleen are as follows: A tumour may be seen or felt in the left hypochondrium. The spleen enlarges downwards and forwards towards the umbilicus, and may extend also downwards towards the anterior superior spine of the left ilium, and to the right of the mid-line. A notch can usually be felt on its superior border. The loin is not filled by the tumour. It moves slightly with respiration, unless fixed by adhesions. It is dull on percussion, and the dulness extends backwards to fuse with the normal area of splenic dulness over the left lower chest behind. There is no band of intestinal resonance running across the dull area, but the flank behind the tumour is usually resonant.

Differential Diagnosis. Other swellings in the left hypochondrium which must be excluded are a renal or adrenal tumour, a growth of the stomach or colon, a pancreatic or ovarian tumour, and tuberculous peritonitis. With renal tumours there are generally urinary changes, and the characteristic signs are present. A barium meal or enema will assist in excluding a growth in the stomach or colon. Pancreatic tumours, when palpable, are usually cysts, appearing on the surface near the midline. An ovarian tumour could only be mistaken for a very large splenic tumour, but pelvic examination will indicate its origin. Tuberculous lymph nodes with peritonitis do not usually give the typical signs of an enlarged spleen.

with the signs of internal hæmorrhage, and a laparotomy is necessary to save life.

Perisplenitis

This occurs especially in connection with splenic infarction. The patient complains of pain over the spleen, increased on respiration. A coarse rub may be heard over the spleen, at the back of the chest or in the left hypochondrium.

Erythrocytosis

(Secondary Polycythæmia)

Definition. An increase in the number of red cells in the blood due to some known stimulus.

Etiology. The bone marrow is provoked to increase its output of red cells under various conditions interfering with the oxygen supply, such as high altitudes, congenital heart disease, pulmonary arterio-sclerosis (Ayerza's disease), pulmonary arterio-venous aneurysm, emphysema, heart failure, Cushing's syndrome, chemical substances, such as cobalt, etc.

Erythræmia

(Polycythæmia Rubra or Vera. Vaquez's Disease. Osler's Disease)

Definition. A condition characterised by an increase in the number of red cells in the blood, with splenomegaly.

Etiology. The cause is unknown. It has been suggested that there is thickening of the vessels supplying the bone marrow, the resultant anoxia stimulating erythropoiesis.

Pathology. There is hyperplasia of marrow in the long bones. The spleen is enlarged and may contain infarcts.

Clinical Findings. The patient is usually middle-aged, of either sex; other members of the same family may be similarly affected. The onset is insidious with headache, lassitude, giddiness, dyspnoea and insomnia. Epistaxis, or a hæmorrhage from the stomach, uterus and rarely from the lungs may occur. The patient may notice that his face and hands are becoming high coloured. There may be severe pain in the bones, and abdominal pain due to mesenteric thrombosis.

On Examination : The face is typically brick-red, and the ears, lips, hands and fingers may be cyanosed, but are not clubbed. The spleen is enlarged to a variable extent. The heart is not usually enlarged. The blood : The total volume is two to three times the normal. Red cells, 7 to 12 millions per c.mm. Hb. 125 to 150% (18.5 to 22.1 G. Hb./100 ml.) C.I. 0.8 to 0.9. There is polychromasia, and a few normoblasts and reticulocytes are present. The platelets may be increased. White cells, 15,000 to 20,000 per c.mm. Polymorphonuclears 70 to 90%. A few myelocytes are present. The sedimentation rate is delayed owing to the increased packed cell volume. The urine : There is often a trace of

protein and a few casts may be present. Acholuric jaundice may be present. The blood pressure may be raised, as in polycythæmia hyper-tonica of Gaisböck (see p. 283). In these cases there is usually no splenomegaly.

Differential Diagnosis. Erythræmia must be distinguished from erythrocytosis, for which some causative factor can be found. Leucocytosis and increased platelets favour the diagnosis of erythræmia. Enterogenous cyanosis is recognised by spectroscopic examination.

Course and Complications. The disease pursues a chronic course, which is interrupted by remissions. In some cases the red cell count may drop to 3 millions, with an increase of immature white cells, resulting in a myeloid leukæmia or an aplastic anæmia before death occurs. Complications include cerebral thrombosis and heart failure. Cirrhosis of the liver may occur, constituting the Moss syndrome.

Prognosis. Death usually takes place 3 to 8 years after the diagnosis has been made, but the radioactive phosphorus treatment has improved the prognosis.

Treatment. The patient should not eat any meat, liver, kidneys, meat soups or eggs, in order to reduce the iron content of the diet. Venesection affords temporary improvement, 500 ml. should be removed twice a week until the Hb. falls to about 80% (11.9 G. Hb./100 ml.), red cells to about 5 millions and the hæmatocrit reading to about 45%. Phenylhydrazine is seldom used now. Splenectomy is not advisable. Some improvement has been obtained after X-ray treatment of the long bones, if care is taken to avoid stimulation of the bone marrow or the production of aplastic anæmia. Favourable results have been obtained by administration of radioactive phosphorus. The initial intravenous dose is usually 3.8 millicuries. If the red cell count remains above 6,000,000 per c.mm. a second injection may be given 6 months later. The initial dose by mouth of P^{32} is 5 to 8 millicuries; the red cells do not fall for 3 to 6 weeks and the total effect is not produced for 3 months. If a second dose is required 3 to 5 millicuries are given. The P^{32} should be given in the morning after a twelve hour fast and no food should be taken for 8 hours subsequently. Potassium salts of P^{32} must not be given by mouth and for 2 days before and after taking the dose very little milk or potassium-containing foods should be taken. There is a latent period of about 100 days before the effect on the red cells is noted. The metal is concentrated in the bone marrow where it constantly bombards the hæmopoietic tissue. Acute or subacute leukæmia may follow this radiation treatment. Alternatively, nitrogen mustard (mustine hydrochloride) may be given after a preliminary venesection. The dose is 10 to 20 mg., intravenously every 4 weeks until an adequate fall in the red cell count is obtained. Nausea and vomiting may be troublesome side effects of the drug. TEM (triethylene-melamine) can be given by mouth as enteric coated tablets, the dose being 5 mg. a week. The side effects are less troublesome than with nitrogen mustard. It requires strict hæmatological control. Disulpan (Mylern) may also be used (see p. 542). Leukæmia is said not to follow drug treatment.

Enterogenous Cyanosis

(Sulphæmoglobinæmia. Methæmoglobinæmia)

Definition. Cyanosis, due to the presence of sulphæmoglobin or methæmoglobin in the blood.

Etiology. Stockvis, in 1902, described what he called enterogenous cyanosis, in a patient suffering from chronic dysentery whose blood contained methæmoglobin. In these cases it is thought that nitrites are absorbed from the intestines into the blood, and these reduce the hæmoglobin. The reduced hæmoglobin combines with the small amount of sulphuretted hydrogen normally present and sulph. Hb. or met. Hb. is formed. A nitrifying organism (nitroso-bacillus) has been isolated from the saliva and feces in some cases, and reducing substances are present in the serum, urine and saliva of patients suffering from the disease. In 1925 Snapper suggested that the hæmoglobin is sensitised by aniline drugs and then unites with sulphides absorbed from the intestines. Potassium chlorate, acetanilide (antifebrin), antipyrin (phenazone), phenacetin, nitrites and sulphonal may cause methæmoglobinæmia. Nitrates in drinking water used in making up artificial feeds may cause the syndrome known as "blue-water babies." Similar cases have resulted from absorption through the skin of aniline dye from marking ink on infants' napkins. Sulphæmoglobinæmia may occur in connection with sulphonamide therapy. Whether sulphæmoglobinæmia or methæmoglobinæmia develops in sensitised patients appears to depend upon the degree of constipation present, but this is not always so. A few cases of familial idiopathic methæmoglobinæmia have been described, differing from enterogenous cases by a normal nitrite content in the blood, urine and saliva, whereas in enterogenous cyanosis, the nitrite content may be increased.

Clinical Findings. The patient is usually an adult of either sex. The onset of symptoms is insidious with headache, weakness, fainting attacks and nervous instability. Nausea, vomiting and abdominal pains may be complained of. There is mild or transitory constipation with methæmoglobinæmia and severe and chronic constipation with sulphæmoglobinæmia.

On Examination: The patient has a peculiar cyanosis, which is mauve-lavender in colour in sulphæmoglobinæmia and blue-chocolate-brown in methæmoglobinæmia. This, again, is not always so. No physical cause for the cyanosis can be found on clinical examination. The blood: Spectroscopic examination shows the band of met. Hb. or sulph. Hb. between the C and D lines of the spectrum, further spectroscopic tests differentiating them. The pigment absorption band may be seen with a hand spectroscope through the lobe of the ear, but for accurate determinations laked diluted blood should be examined in the laboratory and special differentiating tests applied. The pigment is not present in the serum or in the urine. A clinical test to distinguish between the types is as follows: If the brown muddy colour disappears from the blood on standing exposed to the air for several hours the condition is methæmoglobinæmia due to an ingested chemical. If the colour

remains it is due either to sulphæmoglobinæmia or to congenital methæmoglobinæmia.

Differential Diagnosis. Other causes of cyanosis, especially diseases of the heart and lungs, are excluded on clinical examination.

Course and Complications. The course in the enterogenous cases is prolonged, and complete recovery is doubtful. In some cases intermissions and relapses correspond with periods of freedom from, or affection with marked constipation.

Prognosis. The condition is not fatal, but a permanent cure is unusual.

Treatment. In all cases an exhaustive search should be made to exclude the use of such sensitising drugs as phenacetin, antifebrin (acetanilide), sulphonal and potassium chlorate. The constipation must be treated by the regular use of laxatives, avoiding those containing sulphur. The cyanosis of methæmoglobinæmia can often be abolished by the administration of a methylene blue pill, 2 gr. (120 mg.) 3 or 4 times a day, or by the intravenous injection of 1 mg./kg. body-weight in a 1% solution. A maintenance dose of 1 gr. (0.06 G.) every other day may prove sufficient. In the congenital variety of methæmoglobinæmia, with an intake of 300 mg. ascorbic acid, daily for a month, the percentage of methæmoglobin in the blood can usually be sufficiently lowered to abolish cyanosis, but on discontinuing the ascorbic acid the cyanosis reappears. The change from methæmoglobin to hæmoglobin can also be effected *in vitro*.

PURPURA

Definition. A condition characterised by extravasation of blood into the skin and mucous membranes, due to capillary hæmorrhage.

Etiology. Purpura is a sign and symptom occurring in many pathological states. For clinical purposes it is divided into a primary and secondary group. Primary or idiopathic purpura is also known as the *hæmorrhagic diathesis*; it arises apart from any known cause. Secondary or symptomatic purpura is a symptom of some recognisable disease. The following varieties are thus described:

1. *Primary or Idiopathic Purpura.* The cases fall into two groups: (a) With a low platelet count. Purpura hæmorrhagica. (b) With a normal or slightly reduced platelet count, but with an abnormal capillary endothelium. Purpura simplex. Purpura rheumatica, Henoch's purpura. Allergic purpura. These are all classified as anaphylactoid purpuras. Purpura fulminans is also non-thrombopenic.

2. *Secondary or Symptomatic Purpura.* This may be due to: (a) Bone marrow defects with a low platelet count. Blood diseases include pernicious anæmia, aplastic anæmia and leukæmia. Secondary carcinomatosis of bone. Chemical causes, such as iodides, mercury, quinine, belladonna, ergot, chloral hydrate, gold, arsenic, sulphonamides, turpentine, Tridione, phenacetin, Sedormid, salicylic acid, sodium para-aminosalicylic acid, benzol and snake venom. Exposure to X-rays, radium and atomic-bomb explosion. (b) Alterations in the

capillary endothelium. Infections, such as septicæmia and bacterial endocarditis. Fevers, such as cerebrospinal fever, typhus fever, measles, small-pox or scarlet fever. Cachexia, as in old age, chronic nephritis, tuberculosis and carcinoma. Mechanical causes, such as pressure on the skin, whooping-cough, violent vomiting or epilepsy. Nutritional causes, such as lack of vitamin C or P. (c) Deficiency of prothrombin, as in jaundice, cirrhosis hepatis, or dicoumarol poisoning.

Pathology. In hæmorrhagic purpura all the elements of the blood pass through the capillaries. In anaphylactoid purpura the serum alone may pass out into the tissues in some parts of the body, whereas the lesions in other sites are definitely purpuric. In purpura simplex there may be extravasation of red cells only. The lesions produced are thus variable: pinpoint spots constitute petechiæ, the purpuric spots are about 1 to 8 mm. in diameter, and larger extravasations several cm. across are known as ecchymoses. The bleeding may occur into or under the skin, into or from mucous or serous membranes, into the interstitial tissue of internal organs and into the eye. It must be clearly recognised that purpura does not depend merely upon deficiency of platelets in the blood, as there may be a complete absence of platelets without hæmorrhages. The platelets are much diminished in purpura hæmorrhagica ("essential" thrombopenia) and to a lesser degree in the other varieties of purpura, depending upon the severity of the bleeding. The platelets are produced in bone marrow from megakaryocytes and destroyed by the spleen. They probably protect weak surfaces in the capillaries by forming a layer over the intima at such spots, and thus help to prevent extravasation of blood. The essential lesion in purpura appears to be a temporary alteration in the permeability of the capillary endothelium. This may be due to toxins or to proteins to which the patient is sensitive, but this is uncertain. As long as the capillary endothelium is normal extravasation of blood does not occur, even with very low platelet counts. In senile purpura and in corticosteroid purpura there is degeneration of collagen which probably leads to rupture of minute venules of the skin. There is also an impairment of inflammatory reaction. The coagulation time of the blood is normal in purpura, although the clot retracts slowly; the bleeding time is much prolonged in primary purpuras when the platelet count is low. After splenectomy the platelet count rises very rapidly, due partly to an increased output from the marrow and partly to lack of destruction by the spleen, but it may return to its original low level although the patient is relieved of his symptoms.

Purpura Hæmorrhagica

(*Morbus Maculosus of Werlhof. Essential Thrombopenia. Purpura Thrombopenia. Thrombocytolytic Purpura. Primary Hypersplenism. Thrombocytopenic Purpura.*)

Definition. A disease characterised by hæmorrhages into the skin, mucous membranes and internal organs, with a low platelet count.

Etiology. Two types are described: 1. Idiopathic. 2. Secondary

to drugs such as Sedormid, iodides, gold, arsenic, quinine, etc., and to infections, especially pneumococcal and meningococcal.

Pathogenesis. There appear to be two varieties of the idiopathic type. In one, which is more common, the spleen is primarily at fault, the platelets being sequestered in the organ to an abnormal degree—hypersequestration—or there is also increased destruction of platelets by clasmatocytes. The bone marrow shows an increased number of megakaryocytes. In the second variety there is a thrombocytopenic factor in the plasma. The secondary variety, due to drugs and infection, results from bone marrow damage reducing the production of platelets. In Sedormid sensitivity an antibody is found which causes agglutination and lysis of platelets.

Clinical Findings. The disease may show itself in an acute or chronic form. The patient is often about the age of puberty, but the purpura may occur at any age and is more frequent in women. The onset is often sudden with a hæmorrhage from the nose, stomach, kidneys or uterus. Careful enquiry must be made to exclude drug sensitivity, especially that due to Sedormid.

On Examination : Purpuric spots and ecchymoses may be found on the body ; the gums may bleed, but are not spongy as in scurvy. The spleen is enlarged in about one-third of the cases. The temperature is often raised. The blood : The platelets are usually much reduced and may disappear altogether, although the initial symptoms may appear with a platelet count of 100,000 per c.mm. The coagulation time and prothrombin time are normal. The bleeding time may be prolonged to several hours. The retraction of clot in shed blood is poor. There is usually a hypochromic anæmia and the reticulocytes may be increased up to 10% or more. A few nucleated red cells may be seen. There may be a leucocytosis or a leucopenia with relative lymphocytosis. Sternal puncture differentiates between the idiopathic type due to hypersplenism and the secondary type resulting from hypoplasia of bone marrow. It also excludes an acute leukæmic infiltration of the bone marrow.

Differential Diagnosis. Hæmophilia can usually be excluded on clinical grounds. The platelet count and bleeding time are normal and the coagulation time is delayed. Hereditary purpura hæmorrhagica (constitutional hæmogenia) is a disease resembling purpura hæmorrhagica clinically, but differing in its tendency to hereditary transmission, its preference for the female sex, and the often fatal results of splenectomy. In only about 50% of cases is the platelet count low. In scurvy the hæmorrhages are usually in deeper tissues, such as the thighs, the gums are spongy, and there is a history of avitaminosis. In acute leukæmia, the clinical picture may closely resemble that of the hæmorrhagic diathesis. The blood count usually serves to differentiate, but there may be a leucopenia with relative lymphocytosis in acute leukæmia. The capillary resistance test of Hess may be of value in a doubtful case. A circle is marked out on the forearm, an inch (2.5 cm.) in diameter, with its upper margin 2 inches (5 cm.) below the bend of the elbow. The upper arm is compressed with the armlet of a sphygmomanometer, the

Schönlein's Purpura

(*Anaphylactoid Purpura. Allergic Purpura. Purpura Rheumatica. Peliosis Rheumatica*)

Etiology. The cause is unknown. There is no evidence that Schönlein's purpura is a rheumatic infection. It may be due to sensitivity to proteins or to a streptococcal infection.

Pathology. At some sites in the body the capillaries allow transudation of plasma, and at others diapedesis of red cells occurs.

Clinical Findings. The patient is often a young adult male. There may be fever and sore throat at the onset, with pain in various muscles and joints. Swelling of joints may also be noted.

On Examination: The temperature may be raised to about 100° F. (37.8° C.) for the first few days of the illness. The affected joints, such as the knees or ankles, are slightly swollen and tender, but the skin is not discoloured. The skin: The cutaneous changes include purpuric spots, usually on the extensor surfaces of the legs, and urticarial wheals. Angio-neurotic swellings may appear in the legs, feet, face or hands. The blood: Usually the platelets are not diminished, and the bleeding and coagulation times are normal.

Differential Diagnosis. The fever, sore throat and joint pains are suggestive of acute rheumatism, and the hæmaturia of acute nephritis. The purpuric spots and urticarial swellings are diagnostic, and there is no response to salicylates.

Course and Complications. The course may be prolonged for several weeks and relapses occur. In some cases there are intestinal symptoms characteristic of Henoch's purpura. The urine may contain protein and blood.

Treatment. The patient must be kept in bed. Antihistamine drugs, such as Thephorin 25 mg. tab. t.i.d., may be given. Salicylates do not relieve the joint pains. In cases associated with nutritional deficiency vitamin P should be administered in the form of Hesperidin tab., 150 mg. four times a day. Later, any septic focus in the mouth or elsewhere should receive treatment.

Henoch's Purpura

Definition. This is a more severe form of Schönlein's purpura, characterised by abdominal crises due to an exudation of plasma or blood into the wall of the intestines.

Clinical Findings. The patient may be an infant or adult, who is seized with severe abdominal pain, vomiting, diarrhoea or constipation, and at times pains in the joints.

On Examination: The abdomen is rigid during the attack. There may be no purpura, or careful search may reveal the presence of a few spots. Urticaria and swelling of the joints may also be present. The blood: The platelets are usually normal and there is no change in the bleeding or coagulation times. Blood and mucus may be passed per rectum, and the temperature is raised.

Differential Diagnosis. The disease is liable to be mistaken for an

pressure being maintained for 15 minutes mid-way between the systolic and diastolic readings. The cuff is then removed, and 5 minutes later the number of hæmorrhagic spots which have appeared within the circle is counted. Anything above 20 is abnormal and indicates increased capillary fragility. Some cases diagnosed as essential thrombopenia prove to be congenital nasal telangiectases.

Course and Complications. The course may be rapidly fatal, or more prolonged with intermissions, or definitely chronic, with recurrent hæmorrhages and purpura for several years. In many cases death is due to subdural hæmorrhage. Cerebral or cerebrospinal hæmorrhage may occur as a complication.

Prognosis. This is always very grave in acute cases. Chronic cases are more benign and there is a tendency to spontaneous improvement.

Treatment. Splenectomy is indicated when it has been demonstrated that the spleen is primarily at fault. This must be preceded by a series of blood transfusions. Relapses occasionally occur, these are either due to accessory splenic tissue in the body at some other site, or to a thrombocytopenic plasma factor being present. Prednisolone 40 to 60 mg. daily may produce remissions lasting for several months, and is worth a trial before splenectomy is advised. In secondary cases also treatment should be directed to the primary cause. If due to gold or arsenic dimercaprol (British Anti-Lewisite. BAL) should be given. It is put up as a 5% solution of dimercaprol in arachnis oil containing 1% v/v of benzyl benzoate. Each 2 ml. ampoule contains 100 mg. BAL. The dose for an adult is 100 mg. intramuscularly four times during the first 24 hours at four-hourly intervals. On the second to fourth days 100 mg. morning and evening, and on the fifth and sixth days 100 mg. daily.

Purpura Simplex

Clinical Findings. This disease was very common 20 or 30 years ago, but is now rarely seen. It is considered to be an allergic manifestation. The patient is usually a child or young adult, who gives a history of slight malaise, with perhaps headaches, fleeting pains in the joints or diarrhoea. The patient complains of lassitude with pains in the shoulders and legs.

On Examination: Small purpuric spots are seen chiefly on the extensor surface of the legs. The trunk, arms and rarely the face may be involved. The spots come out in crops and the temperature may be slightly raised. Hæmorrhages do not occur from the mucous membranes. The blood: The platelets are usually normal. The coagulation time is normal. The bleeding time is normal.

Course and Complications. 5 or 6 weeks may elapse before the spots finally disappear. Recurrences are often noted.

Prognosis. This is good.

Treatment. The patient should be in bed until the purpura disappears. Treatment is symptomatic.

Schönlein's Purpura

(*Anaphylactoid Purpura. Allergic Purpura. Purpura Rheumatica. Peliosis Rheumatica*)

Etiology. The cause is unknown. There is no evidence that Schönlein's purpura is a rheumatic infection. It may be due to sensitivity to proteins or to a streptococcal infection.

Pathology. At some sites in the body the capillaries allow transudation of plasma, and at others diapedesis of red cells occurs.

Clinical Findings. The patient is often a young adult male. There may be fever and sore throat at the onset, with pain in various muscles and joints. Swelling of joints may also be noted.

On Examination: The temperature may be raised to about 100° F. (37.8° C.) for the first few days of the illness. The affected joints, such as the knees or ankles, are slightly swollen and tender, but the skin is not discoloured. The skin: The cutaneous changes include purpuric spots, usually on the extensor surfaces of the legs, and urticarial wheals. Angio-neurotic swellings may appear in the legs, feet, face or hands. The blood: Usually the platelets are not diminished, and the bleeding and coagulation times are normal.

Differential Diagnosis. The fever, sore throat and joint pains are suggestive of acute rheumatism, and the hæmaturia of acute nephritis. The purpuric spots and urticarial swellings are diagnostic, and there is no response to salicylates.

Course and Complications. The course may be prolonged for several weeks and relapses occur. In some cases there are intestinal symptoms characteristic of Henoch's purpura. The urine may contain protein and blood.

Treatment. The patient must be kept in bed. Antihistamine drugs, such as Thephorin 25 mg. tab. t.i.d., may be given. Salicylates do not relieve the joint pains. In cases associated with nutritional deficiency vitamin P should be administered in the form of Hesperidin tab., 150 mg. four times a day. Later, any septic focus in the mouth or elsewhere should receive treatment.

Henoch's Purpura

Definition. This is a more severe form of Schönlein's purpura, characterised by abdominal crises due to an exudation of plasma or blood into the wall of the intestines.

Clinical Findings. The patient may be an infant or adult, who is seized with severe abdominal pain, vomiting, diarrhoea or constipation, and at times pains in the joints.

On Examination: The abdomen is rigid during the attack. There may be no purpura, or careful search may reveal the presence of a few spots. Urticaria and swelling of the joints may also be present. The blood: The platelets are usually normal and there is no change in the bleeding or coagulation times. Blood and mucus may be passed per rectum, and the temperature is raised.

Differential Diagnosis. The disease is liable to be mistaken for an

intussusception in an infant or for a mesenteric thrombosis or other variety of abdominal emergency in an adult. A very careful search should be made for purpuric spots, before any operation is performed.

Course and Complications. An attack usually passes off in a day or so. Complications include hæmaturia, intussusception and cerebral hæmorrhage. Relapses are prone to occur.

Prognosis. This is always serious.

Treatment. The patient must be kept in bed, and an icebag applied locally to the abdomen to relieve pain. If this is not successful, tnc. chlorof. et morphin. co. (B.P.C.) 5 to 10 m. (0.3 to 0.6 ml.) may be given to an adult and repeated if necessary. Antihistamine drugs, corticosteroids and vitamin P are worthy of trial.

Purpura Fulminans

A hyperacute variety of purpura which causes death in 1 to 5 days. It has been described following scarlet fever. Infants are chiefly affected, the temperature is raised, and large subcutaneous ecchymoses are seen. The blood shows an anæmia with a normal number of platelets. The Waterhouse-Friderichsen syndrome due to meningococcal septicæmia is a closely allied condition.

The Secondary Purpuras

The conditions with which purpura may be associated have been enumerated on p. 553.

Hæmophilia

Definition. A familial disease characterised by a tendency to bleed severely from trivial injuries.

Etiology. Hæmophilia is due to a "failure or delay in blood thromboplastin formation caused by absence or deficiency in the blood of antihæmophilic globulin." It occurs in males, but is transmitted by females as a Mendelian sex-linked recessive trait (Nasse's law). When a hæmophilic man and a normal woman marry, the male offspring will be normal, but the females will carry the hæmophilic trait. If such a female carrier marries a normal man, the chances are about equal whether their sons are hæmophiliacs or their daughters carriers of the trait. If, however, a hæmophilic man marries a female carrier of the trait the daughters may be true hæmophiliacs.

Clinical Findings. The history frequently suggests the presence of "bleeders" in other male members of the family, and they can often be traced back for more than one generation. The peculiarity is often noted during the second year of life, a trivial injury causing excessive bruising or bleeding if the skin is abraded or cut. Extraction of a tooth may give rise to serious bleeding.

On Examination: Ecchymoses may be seen under the skin or a hæmatoma felt. A joint may be distended with blood, especially the knee or elbow. The affected joint is painful and the skin over it red. The temperature then is usually raised to about 100° F. (37.8° C.). Muscular hæmorrhages may cause pain by nerve pressure. Vitreous,

retinal and orbital hæmorrhages have occasionally been recorded. A large cystic hæmatoma may result from subperiosteal hæmorrhages, usually in connection with the femur. The blood: There may be a hæmorrhagic anæmia. The platelets are not deficient. The bleeding time is normal or slightly prolonged, a prick not causing prolonged bleeding as does a scratch, as the minute wound of the prick is sealed by a mass of platelets. It is therefore quite safe to perform a vein puncture. The coagulation time is prolonged to 5 to 8 times the normal, but it may revert to nearly normal between the attacks. The blood of a normal person contains antihæmophilic globulin, and, when added to the blood of a hæmophilic patient, shortens its clotting time. This is used as a test, the blood of a suspected hæmophiliac is added to that of a known hæmophiliac and the shortening of the clotting time is compared with that obtained with normal blood. During the active stages of the disease the bone marrow may show an increase in megakaryocytes and megakaryoblasts.

Differential Diagnosis. Hæmophilia must be distinguished from simple obstinate bleeding, such as may occur after a dental extraction. This may affect either sex and there is no history of hæmophilia. In purpura hæmorrhagica the prolonged bleeding time and thrombopenia are characteristic. In *pseudohæmophilia* (von Willebrand's disease) there is a prolonged bleeding time, due to a defect in capillary structure and a deficiency of antihæmophilic globulin (plasma factor viii). Severe bleeding is liable to occur from wounds, from the nose, from the gastrointestinal and female genital tracts. *Thrombasthenia* is characterised by a tendency to purpura and hæmorrhages. The bleeding time and platelet count are normal, but clot retraction is defective. *Fibropenia* is a rare disease, in which the blood contains no fibrinogen and so will not clot. In the hæmorrhagic diseases of the newborn the bleeding occurs during the first few days of life, usually with melæna.

Course and Complications. There is a tendency for the condition to improve with the passage of years. Joints which have been affected with a hæmorrhage may become ankylosed by fibrous tissue.

Prognosis. This is always very grave, many hæmophiliacs failing to survive to adult age.

Treatment. The patient must be protected from all varieties of external trauma. A small local hæmorrhage may be sometimes arrested by the application of liq. adrenalin. hydrochlor. on cotton wool, or by normal human blood applied on wool after removal of the clots from the wound. If this fails a sterile 1 in 10,000 solution of Russell's viper venom (Stypven or Rusven) should be applied on gauze. Major surgery should be avoided in all cases of hæmophilia unless it is absolutely essential, owing to the high mortality rate. In all operations, including dental extractions, a plasma transfusion of 1 to 2 litres of fresh plasma, obtained from a suitable donor, should be given immediately beforehand. A second transfusion may be required after a minor operation. After a more severe operation daily transfusions of 500 to 1,500 ml. may be required for 2 weeks, as the wound is slow to heal. Alternatively, fresh frozen plasma, stored at $-20^{\circ}\text{C}.$, may be used. Such plasma

keeps, when frozen solid, for at least a month. A fibrinogen fraction containing antihæmophilic globulin is obtainable from the Lister Institute, London, which is stable at room temperature for several months. It contains about 5 times as much antihæmophilic globulin as does normal plasma. The average dose is 200 ml. The Cohn plasma fraction 1 contains fibrinogen and antihæmophilic globulin, but is said not to be so reliable. Hæmarthrosis is treated by elevating the joint and applying bandages wrung out in iced water. In some cases it is necessary to aspirate the joint. Tooth sockets should not be plugged or sutured.

Christmas Disease

This disease, named after a patient who suffered from it, resembles hæmophilia in clinical and laboratory findings. In 1952 it was shown that in certain patients suffering from hæmophilia, antihæmophilic globulin is present in the plasma. The prolonged clotting is due in these cases to a lack of another factor necessary to the formation of thromboplastin. This so-called Christmas factor is stable, so that transfusions with stored blood are effective in its treatment.

Hæmorrhagic Thrombocythæmia

This is a rare condition, characterised by a great increase of megakaryocytes and platelets in the bone marrow, and by a blood platelet count of 8 millions or more. Thrombosis of the larger veins of the legs and of the mesenteric vessels is liable to occur, also subcutaneous hæmatomata. Treatment with radioactive phosphorus has been effective in some cases.

Hæmorrhagic Disease of the Newborn

(*Melæna Neonatorum*)

Definition. Spontaneous hæmorrhages in newborn infants. They are often premature.

Etiology. The cause is hypoprothrombinæmia due to vitamin K deficiency developing a few days after birth and ceasing usually after the eighth day.

Clinical Findings. During the first 4 to 10 days of life hæmorrhages occur from the umbilicus, stomach or the intestines. There may also be ecchymoses or bleeding from the urinary tract or vagina. The infant appears fretful, does not take its feeds well, and may be jaundiced. The blood: The platelets are not diminished. The coagulation time and bleeding time are prolonged. There is hypoprothrombinæmia.

Differential Diagnosis. Hæmophilia does not often manifest itself at such an early age. Localised hæmorrhages may be due to trauma, such as a cephalhæmatoma. In erythroblastosis foetalis, jaundice is seen. Syphilis and umbilical sepsis may give rise to similar symptoms.

Prognosis. The outlook is grave if the patient fails to respond to adequate treatment.

Treatment. Prophylactic. The mother is given tab. acetomenaphthone, 5 mg. tab., 5 tabs. 12 to 4 hours before the baby is born, and the baby is given 5 mg. by mouth on the first day of its life.

Curative. The baby is given an intramuscular or intravenous injection of 1 mg. in 1 ml. of menaphthone every 6 to 12 hours until the bleeding stops. In severe cases a blood transfusion of 60 ml. of Rhesus negative blood should be injected intravenously and repeated the next day. The injection may be made into the superior sagittal sinus. Intramuscular injections of blood do not appear to raise the prothrombin content of the infant's blood.

Hypogammaglobulinaemia

Electrophoretic study of the serum proteins has shown that in some people the gamma-globulin component is absent or only present in very small quantities. Primary forms may be congenital or acquired. Other cases are secondary to recurring infections. These include pyoderma, purulent conjunctivitis, otitis media, purulent sinusitis, pneumonia, meningitis, and purulent arthritis. It appears that the immune bodies are contained in the gamma-globulin, and the victims of this condition are unable to produce antibodies to various antigens. In some cases monthly parenteral injection of gamma-globulin will keep the patient free from infection.

Macroglobulinaemia

There is a great increase of macroglobulin in the blood. The sedimentation rate of the red cells is raised, and the clotting factors are reduced. It affects the elderly, and is characterised by retinopathy, mild epistaxis, anaemia and increased susceptibility to infection. There may also be heart failure, peripheral neuropathy, and psychosis. In some cases Bence Jones protein is found in the urine.

CHAPTER VIII

THE INFECTIOUS FEVERS

Introductory. Certain terms used in describing the infectious fevers will be defined :—*Incubation period* : The time between infection and the first development of symptoms. *Prodromal period* : The time between the end of the incubation period and the appearance of the specific rash. *Exanthem* : The cutaneous eruption. *Enanthem* : Eruptions on mucous membranes, such as Koplik's spots in measles. *Quarantine period* : The maximum time during which a person who has been in contact with the infection may develop the disease. It is usually 1 to 2 days longer than the maximum incubation period. *Isolation period* : The time the patient must be isolated. *Fomites* (fomes = tinder) : Articles with which a patient, suffering from an infectious fever, has been in contact, and which convey the infection to another person.

Notifiable Diseases. The following diseases are compulsorily notifiable in England, Wales, Scotland and Northern Ireland; it will be seen that other diseases than the infectious fevers are included: Small-pox, cholera, diphtheria, membranous croup, measles, whooping cough, scarlet fever, anthrax (in parts of England and in N. Ireland), hepatitis or infectious jaundice (in parts of England), erysipelas, typhus, the enteric group of fevers, relapsing fever, puerperal pyrexia, plague, cerebrospinal fever, poliomyelitis and polioencephalitis, encephalitis, tuberculosis, ophthalmia neonatorum, dysentery, malaria, acute primary pneumonia, acute influenzal pneumonia and leprosy.

In certain districts the local authority may make other diseases notifiable from time to time, such as chicken-pox when there is an outbreak of small-pox.

Immunisation of Infants and Children

Immunisation has done much to reduce the incidence of infectious diseases. The following programme may be followed :—*Age 2 months.* First injection of 1 ml. of alum-containing triple antigen, diphtheria, pertussis and tetanus (DPT). *Age 3 months.* Second injection of DPT. *Age 4 months.* Third injection of DPT. *Age 5 months.* Small-pox vaccination. *Age 7 months.* First poliomyelitis vaccination. Three drops of Sabin attenuated trivalent live vaccine on a lump of sugar, repeated after 4 weeks and again 4 weeks later, a year later and at the age of 5 and 10 years. *At school entry.* Diphtheria and tetanus vaccination. *Age 7 to 9 years.* Diphtheria and tetanus vaccination. Small-pox revaccination. *Age 10 to 15 years.* B.C.G. vaccination if not done previously, or if Mantoux negative.

If a baby is in contact with an open case of tuberculosis B.C.G. vaccination may be given in the arm at the end of the first month. The

arm in which the injection is made must not be used for other injections for six months.

Measles

(*Morbilli. Rubeola. (On the Continent Rubeola is synonymous with Rubella)*)

Definition. An acute infectious disease, characterised by early catarrh and fever and followed by a typical rash.

Etiology. The cause is a virus which affects man and monkeys. The disease is spread by direct contact, probably through droplet infection on sneezing or coughing. It is very infectious during the early catarrhal stage, before the appearance of the rash. *Predisposing causes:* 1. Age: The maximum incidence is between 8 months and 5 years. 2. Absence of a previous attack: Second attacks of genuine measles are very rare. 3. Season: Epidemics occur in the winter and spring, and are more virulent and extensive in alternate years. 4. Sex, climate and race play no part.

Pathology. Multinucleate giant cells, apparently characteristic of measles, may be found in tonsillar or appendicular tissue removed by operation during the prodromal period of the disease. There are no special post-mortem changes. Death is usually due to complications, especially bronchopneumonia.

Incubation Period. 7 to 14 days, usually 10 to 11 days.

Clinical Findings. The patient is usually a child. A few hours after exposure to infection he may develop symptoms of measles and even a transient morbilliform rash. This is called the "illness of infection." It disappears in a day or so and the measles may then develop after the usual incubation period. The onset is with catarrh of the eyes, photophobia, sneezing, nasal discharge and malaise. A cough, laryngitis or diarrhoea may also be noted. A prodromal rash sometimes occurs which may be scarlatiniform or morbilliform in character.

On Examination: On the first day the patient appears flushed, the conjunctivæ are injected, the temperature is raised to 99° or 100° F. (37.2° or 37.8° C.) or over. A characteristic enanthem is found, Koplik's spots being seen in over 90% of cases. They are small, bluish-white slightly raised spots (due to necrosed epithelium) on a bright red base, about the size of a pin's head, seen inside the cheeks opposite the premolar teeth. The arcolæ are often confluent and the spots may spread over the mucous membrane of the cheeks and lips. The temperature often falls to, or below normal on the second or third day (remission of measles), and rises again on the evening of the day before which the rash appears (third day) to 102° F. (38.9° C.) or over, and continues to rise until the rash is well out. In an uncomplicated case the temperature falls gradually to normal during the next 48 hours as the rash fades (see Fig. 50), but the rash and fever may last for 4 or 5 days. Koplik's spots usually fade with the appearance of the exanthem.

The rash is first seen on the forehead near the hair and behind the ears. It spreads usually within 24 hours to the face, neck and trunk,

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If a baby is in contact with an open case of tuberculosis B.C.G. vaccination may be given in the arm at the end of the first month. The

pulmonary tuberculosis, or general enlargement of lymph nodes may develop as sequelæ. Relapses are extremely rare.

Prognosis. This is very good apart from complications. Measles is now a milder disease than it was formerly. The case-fatality rate in Great Britain, i.e. the number of deaths per 1,000 notifications, is less than one.

Treatment. Prophylactic. Owing to the usual mild nature of the illness, prophylaxis is generally only required in weakly children under the age of 5 years or those attending day nursery schools and residential institutions. Prophylactic injection of an attenuated strain of living measles virus (Wellecovax) produces a high degree of immunity. A mild non-communicable measles-like illness is produced in some cases. The instructions given with the pack must be carefully followed. Contraindications include pregnancy, steroid therapy, active infection, sensitivity to egg protein, etc.

In cases in which prophylactic vaccination is theoretically contra-indicated but which are at great risk of contracting measles, the live attenuated vaccine may be injected 4 to 6 weeks after an injection of inactivated measles vaccine. Alternatively, 0.01 to 0.02 ml. per kg. body weight of human immune gamma-globulin may be injected at the same time, but at a different site, as the injection of the live attenuated vaccine. **Quarantine period.** This is 3 weeks for contacts. They need not be kept from school for the first week, but should be isolated from all children under the age of 5 years, and subsequently should be examined daily for early signs such as catarrh, fever, Koplik's spots and a prodromal rash. **Isolation period.** This is 2 weeks from the appearance of the rash.

Curative. The patient must be put to bed immediately, and kept there for 2 to 3 days after the temperature is normal.

If there is high fever or much irritation, the skin should be tepid sponged once or twice a day. The eyes should be bathed with warm boracic lotion 2 or 3 times daily and Vaseline put on the lids. A drop of sulphacetamide sodium (Albucid) may be instilled into the eyes every 4 hours. The inside of the mouth should be cleansed before and after meals with cotton wool dipped in H_2O_2 (10 vols.) diluted 8 times with water. In order to prevent or lower the incidence of bronchopneumonia

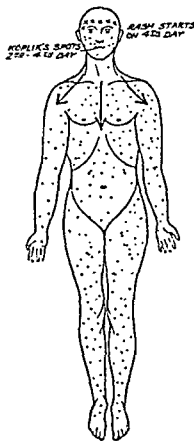


FIG. 51. DIAGRAM OF RASH IN MEASLES.

Rash spreads downwards back and front, arms, legs, palms and soles, for 24 to 36 hours and fades about 2 days later, leaving some staining and branny desquamation. The crosses indicate the usual site of the first appearance of the rash.

and to the limbs, hands and feet, including the palms and soles (see Fig. 51). The rash, at first macular, rapidly forms papules of a dull red colour varying in size from about 2 to 6 mm. with an irregular, blotchy appearance. The papules tend to coalesce and form crescentic areas whose colour fades on pressure, the intervening skin being white. Confluence may lead to areas of diffuse erythema, especially on the back, and very rarely small vesicles may form on the spots. The rash begins to disappear in 2 to 5 days in the order of its appearance, becoming brownish, and leaving some staining which may persist for 1 to 2 weeks. This is followed by a branny desquamation in many cases. The rash may be slight and abortive, and the skin is often moist and itching. The tongue is usually covered with a whitish-yellow fur. The blood: There is often leucocytosis during the invasion period, followed by leucopenia with a relative increase in the large lymphocytes. The urine: Febrile proteinuria is frequently found. There is often some bronchitis.

Varieties. In some cases no rash follows the typical early symptoms. Petechial hæmorrhages may occur in the spots. Toxæmia may be very severe or suffocative symptoms appear early in the disease.

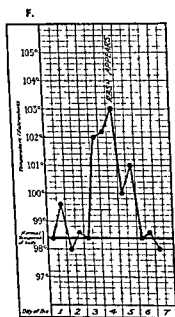


FIG. 50. TEMPERATURE CHART IN MEASLES.

Differential Diagnosis. During the invasion period the disease may be mistaken for a cold, influenza, laryngeal diphtheria, bronchitis or enteritis.

The age of the patient, history of exposure to infection and, above all, the presence of Koplik's spots are of value in making a diagnosis. The rash may be mistaken for that of rubella, the prodromal rash of small-pox or scarlet fever, syphilitic roseola, a serum rash, septic rash, intestinal rash, post-vaccinal eruption, drug rashes or for that of typhus fever.

Course and Complications. The typical course has been described above, but this may be seriously modified by complications. The most important of these are: Bronchitis, bronchopneumonia, laryngitis, laryngeal ulceration, pleurisy, empyema, diphtheria, enlargement of cervical

lymph nodes, blepharitis, corneal ulceration, panophthalmitis, herpes facialis, otitis media, cancerum oris and noma pudendi. Convulsions are not uncommon; encephalitis, myelitis, cerebellar syndromes, toxic psychoses, osteomyelitis and nephritis are rare. Nervous complications are most likely to occur between the third and fifth days of the exanthem, or the eighteenth and twentieth days of convalescence. Enteritis ranks next to bronchopneumonia as the most serious complication. It may occur during the prodromal stage, in the eruptive period, or after the rash has faded. Bronchial lymph node or

jaw, the mastoid, axillary, and inguinal lymph nodes. Suppuration does not occur. The conjunctivæ may be slightly inflamed and the spleen just palpable. The blood: Lymphocytosis is usually present before the rash comes out, later there is leucopenia. The urine is usually normal.

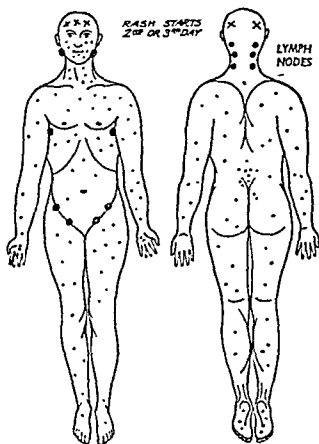


FIG. 52. DIAGRAM OF RASH IN GERMAN MEASLES.

Rash spreads rapidly to face, neck, trunk and limbs. Legs are less affected than arms. The rash usually fades in 36 hours and leaves no staining. The crosses indicate the usual site of the first appearance of the rash. The black circles indicate lymph nodes.

and otitis media, sulphadimidine may be given for 5 days in doses varying with the age of the patient, e.g. 1 G. t.i.d. for a child of 5 years, or penicillin may be injected intramuscularly. The patient should be encouraged to blow his nose from time to time. For otitis media, penicillin should be dropped into the ear every 4 hours, using 1,000 units to 1 ml. distilled water. Encephalomyelitis is treated by lumbar puncture to relieve pressure, and by the intravenous injection of 20 ml. of serum from a patient convalescent from measles encephalitis.

German Measles

(*Rubella. Röteln*)

Definition. An acute infectious disease characterised by fever enlargement of lymph nodes and a typical rash.

Etiology. The cause is a virus. Rubella is spread by direct contact, probably by droplet infection from the naso-pharynx. *Predisposing causes:* 1. Age: Children and young adults. 2. Season: The greatest number of cases develop in the first half of the year. 3. Absence of a previous attack: Second attacks are very rare.

Pathology. There is no morbid anatomy, for death practically never occurs.

Incubation Period. 5 to 21 days, usually 17 to 18 days.

Clinical Findings. The patient is usually a child or young adult. Often the first symptom noticed is the rash, although there may be headache, malaise, sore throat and nasal catarrh for a day or so earlier, or stiffness in the back of the neck, due to the enlarged lymph nodes. An acute onset with a rigor, stiff neck and occipital headache may occur.

On Examination: During the invasion stage the temperature is usually raised to 99° or 100° F. (37·2° or 37·8° C.), the eyes are somewhat pink, and enlarged lymph nodes are felt at the back of the neck. There are no prodromal rashes. The rash appears usually on the second or third day, first on the forehead and behind the ears, then the face, trunk and limbs are involved (see Fig. 52). The rash consists of small macules and papules nearly circular and about 1 to 4 mm. in diameter. The colour is pink or light red. The rash disappears from the face in 12 to 24 hours and there is no staining, but slight desquamation may occur. The rash is more confluent on the trunk and may be almost scarlatiniform; on the extremities it is more morbilliform, irregularly blotchy in character, and frequently involves the palms and soles. It usually fades completely in 36 hours. The temperature falls by remissions and reaches normal on the second or third day after the appearance of the rash. There may be very slight or no pyrexia (see Fig. 53). The lymph nodes: The following groups especially are enlarged: Suboccipital, posterior cervical, those at the angle of the

cervical lymph node enlargement and otorrhœa; hæmorrhagic, with bleeding in the skin and mucous membranes; surgical, following burns or operations; and puerperal.

Differential Diagnosis. During the invasion period scarlet fever must be diagnosed from tonsillitis and diphtheria. A swab should be taken from the throat if exudation is present. The rapid onset of the rash usually serves to establish the diagnosis. The rash must be diagnosed

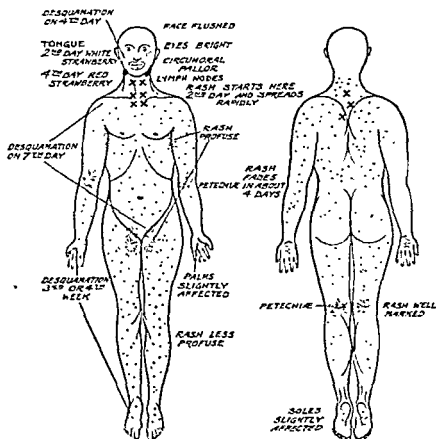


FIG. 51. DIAGRAM OF RASH IN SCARLET FEVER.

The crosses indicate the usual site of the first appearance of the rash. The black circles indicate lymph nodes.

from the following: Measles rash, rubella rash, septic rashes, enema rash, flannel rash, prodromal rash of small-pox, erythema due to influenza, drug rashes due to belladonna, salicylates, and quinine. The distinguishing characters of the rashes due to the infectious fevers are considered under their separate headings. The following test is of value:

The Dick Test. Two-tenths of a ml. of the appropriate dilution of the scarlet fever streptococcal toxin are injected intradermally, and the cutaneous reaction compared with that resulting from a similar injection of the control heated toxin. The test is positive during the first 3 days of scarlet fever in about 90% of cases, and becomes negative in about 10 days' time or later. If the test is negative at the early stage, the disease is probably not scarlet fever.

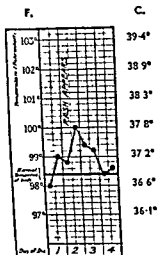


FIG. 53. TEMPERATURE CHART IN GERMAN MEASLES.

simulate rubella, but are usually differentiated by the history and absence of typical clinical findings.

Course and Complications. The course is as described above. The patient is generally quite well in a week and there are usually no complications, although bronchitis, stomatitis and severe muscular pains sometimes occur. Encephalitis is a very rare complication. In 10% to 50% of cases of rubella occurring during the first 8 to 4 months of pregnancy the child is born with a congenital defect, such as cataract, acyanotic heart disease, deaf-mutism, microcephaly or mental retardation. A purpuric rash and hepatosplenomegaly may also occur.

Prognosis. This is good.

Treatment. *Prophylactic.* Gamma-globulin, prepared from convalescent German measles plasma or normal gamma-globulin in doses of 750 mg. should be injected into women contacts in the first 4 months of pregnancy. *Quarantine period* for susceptible contacts is 21 days. *Isolation period.* The patient should be isolated for 7 days from the appearance of the rash.

Curative. The patient should be put to bed and kept there for 2 days after the rash has disappeared. No special treatment is required beyond that applicable to a mild degree of pyrexia.

Scarlet Fever

Definition. An acute infective disease characterised by fever, sore throat, a typical rash and subsequent desquamation.

Etiology. Scarlet fever is due to group A hæmolytic streptococci, which produce an erythrogenic toxin. The latter is responsible for the rash, congested fauces, and red tongue. Infection is spread by droplets and fomites (clothes, toys, books, etc.).

Incubation Period. 1 to 8 days, usually 2 to 3 days.

Clinical Findings. The onset is with headache, sore throat, and vomiting. The temperature rises to about 102° F. (38.9° C.), and the rash appears on the second day, on the neck, front of chest, trunk, limbs and especially in the flexures (see Fig. 54). It is a punctate erythema, fading on pressure, and there is circumoral pallor. Fine desquamation begins on the fourth day on the face, called pin-hole peeling. There is a "white-strawberry" tongue on the second day, and a "red-strawberry" tongue on the fourth day. A throat swab should be taken at the onset to exclude diphtheria; and an enema rash or drug rash has to be excluded in some cases. The temperature falls by lysis about the fifth day (see Fig. 55).

Varieties. Scarlet fever may be abortive; malignant, with profuse toxæmia ending fatally in about 2 days; septic, with tonsillar ulceration,

Complications. Focal nephritis may occur during the first week, and acute glomerulonephritis during the third week. Arthritis, otitis media, endocarditis, and pericarditis are also important complications.

Treatment. *Prophylactic.* Contacts should be given benzylpenicillin, 500,000 units (800 mg.) twice daily, and sulphadimidine 0.25 G. t.i.d. for 5 days. *Curative.* In a mild case the patient is in bed for 2 weeks.

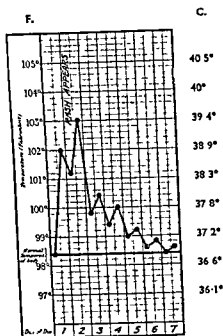


FIG. 55. TEMPERATURE CHART IN SCARLET FEVER.

The diet is fluid or light for a week. For the sore throat a hot normal saline mouthwash, with aspirin 5 to 10 gr. (0.3 to 0.6 G.) four hourly will afford relief. Procaine penicillin, 300,000 units, should be injected intramuscularly every 12 hours. In very toxic cases "Streptococcus Antitoxin-Scarlatina" should be injected intramuscularly, intravenously, or intraperitoneally, in doses of 3,000 to 30,000 units.

Diphtheria

Definition. An acute infective disease characterised by localised membrane formation and toxæmic disturbances.

Etiology. This disease is caused by the *Corynebacterium diphtheriae* (Klebs-Loeffler bacillus), of which three types are described, a gravis, intermedius, and mitis. Infection is spread by droplets, by fomites (pencils, etc.), and by milk.

Incubation Period. 2 to 10 days, usually 3 to 4 days.

Clinical Findings. There are three clinical types, faucial, laryngeal, and nasal. In faucial diphtheria the patient is usually a child who feels ill, but may not complain of the throat. Greyish-yellow patches appear

rash comes out (see Fig. 57). The blood : There is a lymphocytosis for a few days while the rash is out.

Varieties. 1. *Hæmorrhagic* : Hæmorrhages appear and there may also be bleeding from the mucous membranes and hæmarthroses. This is very rare but it is not necessarily fatal. 2. *Gangrenous* : There is necrosis of the skin and subcutaneous tissues. It is met with in debilitated children and is usually fatal.

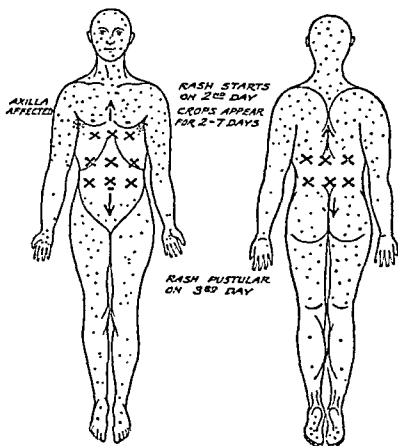


FIG. 56. DIAGRAM OF RASH IN CHICKEN-POX.

The crosses indicate the usual site of the first appearance of the rash.

Differential Diagnosis. This necessitates a consideration of the possibility of small-pox, or of skin diseases such as impetigo, scabies, lichen urticatus, pemphigus and generalised herpes, and of scarlet fever in the invasion stage. The chief distinguishing features of chicken-pox are the absence of severe symptoms during the invasion period, the distribution of the rash, its appearance in crops and the absence of a secondary temperature (see also small-pox, p. 577). Careful attention to the character of the lesions usually serves to distinguish other skin conditions. The presence of lesions in the mouth, is strongly in favour of chicken-pox.

Herpes zoster is now thought to be caused by the same virus as that which produces chicken-pox, perhaps it acts through the nervous

10 units b.i.d. for 2 days. Procaine penicillin should be injected intramuscularly, 600,000 units every 12 hours for 2 days. Tracheostomy or laryngeal intubation may be required for laryngeal obstruction. For peripheral circulatory failure the foot of the bed should be raised, and corticosteroids and oxygen administered. A respirator is required for diaphragmatic paralysis.

Chicken-pox

(*Varicella*)

Definition. An acute infectious disease, characterised by a vesicular eruption appearing in successive crops, and usually fever.

Etiology. The causative organism is a virus. Infection is spread by direct contact, and possibly slightly by fomites, through air, or by a third person. The virus is presumably inhaled. *Predisposing causes:*

1. Absence of a previous attack: Second attacks are rare. 2. Age: Children under 10 are chiefly affected. 3. Association with a person suffering from herpes zoster which is considered to be caused by the same virus. Chicken-pox occurs at all seasons: race and climate play no part in its incidence.

Pathology. The disease is very rarely fatal, and has no definite pathology.

Incubation Period. 11 to 21 days, usually 14 days.

Clinical Findings. The patient is generally a child, but adults are also liable to infection. The rash may be the first symptom, or there may be an invasion period of 1 or 2 days in which there is malaise, headache or shivering.

On Examination: At the onset there is slight pyrexia and prodromal rashes are occasionally seen, especially of a scarlatiniform type which may be generalised. Prodromal hæmaturia has also been described. The true rash appears on the second day and passes rapidly from macule to papule, and then to the typical vesicular eruption.

The vesicles become pustular before they burst in about 24 hours' time. The rash comes out in crops for 2 to 7 days, so that spots in the various stages are seen simultaneously in close proximity. The eruption first appears on the trunk and spreads centrifugally to the face, scalp and upper parts of the limbs. The legs, forearms, hands and feet are involved to a lesser degree, and the spots may be seen in the axilla and on the palate (see Fig. 56).

The vesicles are oval, of varying size averaging about 1 by 3 mm. with a small red areola. They feel smooth and are superficial. On the scalp, hands and feet they are deeper and more shotty. Usually they are not umbilicated and collapse on puncture. The vesicles are generally discrete, but a few may coalesce. The crusts take from 4 days to 4 weeks to separate and may leave white scars which last for many years. The skin usually irritates intensely when the rash is profuse. The temperature: This is variable and usually slight, but in a severe case may be considerably raised for a few days; not falling as the

inhaled. *Predisposing causes* : 1. Absence of protection by vaccination. 2. Absence of a previous attack. 3. Season : Epidemics tend to occur in the winter and spring. 4. Race and climate : Small-pox is more common in the tropics, especially where the disease has not been endemic. 5. Age and sex : Earlier epidemics, such as those of 1783-1800 and 1837-40, affected chiefly children under 5 years, now youths and adults of either sex are attacked.

Pathology. At autopsy, eruptive lesions may be seen in the

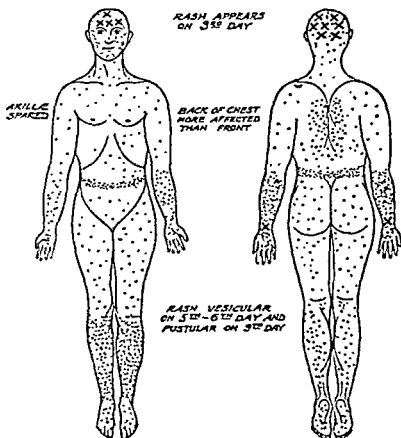


FIG. 58. DIAGRAM OF RASH IN SMALL-POX.

Peripheral extensor surfaces of limbs especially involved. Rash profuse on pressure points such as waist or garter line. The crosses indicate the usual site of the first appearance of the rash.

oesophagus, larynx and trachea. Hæmorrhage may occur in the muscles and solid organs. Small yellow areas of focal necrosis are often found in the testicles. The spleen may be enlarged and soft.

Incubation Period. 10 to 14 days, usually 12 days.

Clinical Findings. The patient may be a child or an adult. He is suddenly taken ill with shivering or a rigor, headache and backache. Giddiness, nausea, vomiting and severe malaise are often present.

On Examination : During the invasion period, the patient looks tired, and the temperature is often raised during the first 2 days, to 102° or 103° F. (38.9° or 40° C.). *Prodromal rashes* may be seen ; these are : 1. Petechial, involving especially the bathing-drawers area

system in the former and through the blood in the latter. Its distribution is related to cutaneous nerve areas.

F.

C.

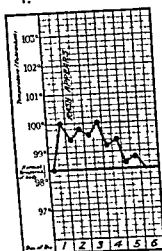


FIG. 57. TEMPERATURE CHART IN CHICKEN-POX.

Course and Complications. Varicella usually pursues a mild course. Complications are infrequent, but include nephritis, laryngitis, virus pneumonia, the X-ray film showing wide-spread nodosities in both lungs, encephalomyelitis, conjunctivitis and otitis media. Encephalomyelitis is characterised by tremors, ataxia, or by signs of transverse myelitis. It may occur during the second week of the illness and be heralded by fever, vomiting, or a rigor. Varicella is more frequently associated with scarlet fever than with any other acute infection.

Prognosis. This is very good except in the severe types of the disease. Recovery usually occurs in cases of encephalomyelitis.

Treatment. *Prophylactic.* Inoculation with convalescent serum has only proved moderately effective. *Quarantine period.* This is 21 days, but the contacts need not be isolated for the first week. *Isolation period.* The patient must be isolated until the last scab has separated, which usually takes 3 to 4 weeks.

Curative. The patient must be put to bed until the temperature is normal, fresh spots have ceased to appear and all spots have reached the crusting stage. Usually the only treatment required, beyond that necessary for any mild feverish illness, is a local application for the irritating skin. The patient should not be allowed to scratch the spots. A dusting powder of equal parts of talc, zinc oxide and borax may be applied, and baths given when the crusts form, with warm water coloured pink with potassium permanganate. In cases with secondary infection of the lesions benzylpenicillin should be given in doses of 50,000 units (30 mg.) intramuscularly every 12 hours. A swab should also be taken to exclude the presence of *C. diphtheriae*. Zinc ointment (ung. zinc. oxid. B.P.) is applied to the sores left after the crusts have separated. Dexamethasone may be given for convulsions.

Small-pox (Variola)

Definition. An acute infectious disease characterised by fever and a typical rash.

Etiology. Paschen bodies, which are present in the fluid of the pocks, are probably the causative virus. Guarnieri bodies which are found in the epithelial cells of the pocks of small-pox are considered to be agminations of Paschen bodies. Infection is spread directly, by fomites, by third persons and probably by flies, the virus being

week (see Fig. 59). During the acute stage the patient is very prostrated and insomnia or delirium may be marked. The blood: There is leucopenia during the first 5 days and leucocytosis during the second and third weeks, with the lymphocytes forming about 40% of the count. The urine: Febrile proteinuria is often present. Laboratory tests of diagnostic aid include the complement fixation test using the contents of the vesicles as the antigen, with serum from sensitised rabbits. Viral antigen in smears from small-pox lesions can be demonstrated by immunofluorescence.

Varieties. 1. *Discrete*: A mild type. 2. *Semi-confluent*: With little normal skin between the spots. 3. *Confluent*: The pustules fuse and there is much subcutaneous oedema. (These types are judged by the rash on the face and forearms and they are all varieties of *Variola vera*.) 4. *Varioloid* (abortive): Slight cases, often modified owing to previous vaccination. There may be no rash (*variola sine eruptione*). 5. *Variola Minor (paravariola)*, *Alastrim* and *Amaas*: Mild types occurring in Brazil and Africa, which have been reported in England since 1919, and were originally described in Gloucestershire by Jenner. There is no secondary fever, and the rash may come out in crops. Adults are chiefly affected. 6. *Hæmorrhagic*: Two types are described, both very malignant. (a) *Purpuric* (black small-pox) with very scanty rash. Hæmorrhages occur in the skin, mucous membranes and internal organs. (b) *Variola hæmorrhagica pustulosa* in which hæmorrhages occur after the development of the rash, which may not reach the pustular stage. Small hæmorrhages into the pocks do not constitute true hæmorrhagic small-pox and are not necessarily severe. 7. *Congenital*.

Differential Diagnosis. In the invasion stage small-pox may be mistaken for influenza, pneumonia, scarlet fever, measles or purpura. Search should be made for the petechial rash described above. The typical features of the onset of measles and scarlet fever are absent.

When the rash has appeared the differential diagnosis includes: Chicken-pox, measles, typhus fever, pustular drug eruptions such as those caused by iodides and bromides, a pustular syphilide and acne. The distribution of the rash is most important. The greatest difficulty usually occurs in the case of chicken-pox. In small-pox the rash is most profuse on the face and extremities, and in chicken-pox on the trunk. The axilla is usually free from eruption in small-pox, whereas this area is affected in chicken-pox. In small-pox the rash does not come out in crops as it does in chicken-pox. In variola minor, however, fresh skin lesions may appear for up to six days. The pocks stand out prominently and are circular; in chicken-pox they are irregular in outline. The vesicles rarely rupture in variola minor; they contain viscous, opaque, greyish fluid. Electron microscopy distinguishes between small-pox and chicken-pox. In small-pox the typical vesicle is round and rather deep, whereas it is oval and superficial in chicken-pox. Small-pox is the only infectious disease in which the temperature falls with the appearance of the eruption. As mentioned above smears made from the papules are of diagnostic value.

If the patient has recently been successfully vaccinated it is improb-

(triangular rash). There are small bright or dark red spots which may also be found in the axillæ. 2. Erythematous, either scarlatiniform, morbilliform or multiform of a wider distribution. The spleen may be palpable. The true rash appears on the third day and is maculo-papular; it becomes vesicular by the fifth or sixth day, and pustular by the ninth day. The pustules burst about the twelfth day, with crust formation by the sixteenth day. The macules first appear on the forehead, scalp and back of the wrists and spread over the face and peripheral portions of the limbs to the trunk. The rash involves especially extensor surfaces, exposed parts and those subject to pressure. The axillæ are usually spared. It is more scanty on the abdomen, loins, chest, neck and flexures of the limbs. The legs are less involved than the arms, and usually the upper half of the limbs are less involved than the lower.

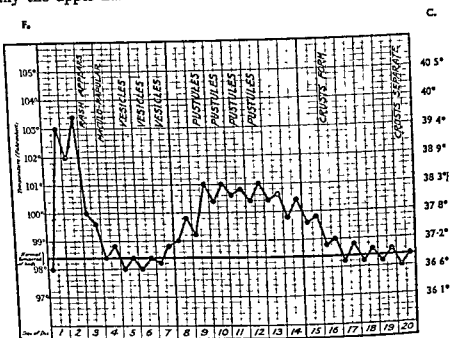


FIG. 59. TEMPERATURE CHART IN SMALL-POX.

The eruption is also seen on the palms, soles, conjunctivæ and in the mouth (see Fig. 58).

The macules vary in size, are dark red and rapidly become papular, firm and shotty. The vesicles are pearl-coloured, and loculated so that they do not collapse on puncture. Umbilication due to depression of the centre by a sweat duct or hair follicle is often seen. The pustules are yellowish with a red areola and the skin around may be cedematous. The brownish-black crusts formed after rupture usually separate in from 2 to 8 weeks, leaving depressed scars which are often permanent.

There is much irritation and the skin may become tense and painful with a very offensive odour during the pustular stage. The temperature usually falls to about 99° F. (37.2° C.) or lower as the true rash appears and rises again (secondary fever) with pustulation, to about 101° F. (38.3° C.) It then gradually falls to normal about the middle of the third

To aid the separation of the crusts, especially from the face, a thin layer of linseed poultice may be applied on a lint mask and changed every 2 hours. When the crusts have separated zinc ointment (ung. zinc. oxid. B.P.) can be applied to the scars.

To relieve the severe pain in the back and the headaches aspirin 10 gr. (0.6 G.) may be given. To induce sleep, Dover's powder (pulv. ipecac. et opii B.P.) 10 gr. (0.6 G.), or paraldehyde 60 to 120 m. (4 to 8 ml.) may be required. Delirium is best relieved by the injection of hyoscin. hydrobrom. 1/100 gr. (0.6 mg.). A steam inhalation containing tnc. benzoini co. 60 m. (4 ml.) to 1 pint (600 ml.) relieves the laryngitis. The mouth should be cleaned after each feed with a swab dipped in glycerin. thymol. co. (B.P.C.) 60 m. (4 ml.) to 5 fl. oz. (150 ml.) of water.

Vaccinia (*Cow-pox*)

Definition. This is a disease of cows. Man may be infected by contact with a cow suffering from the disease. The term also includes the effects of inoculation of man with vaccine lymph containing the attenuated variola virus.

Vaccination. The lymph now used in Great Britain is derived from sheep. Lymph will remain potent when kept in a domestic refrigerator for 2 weeks. If kept in the dark and in a cool place it should be active for about 7 days.

The multiple pressure method is usually recommended. The skin over the posterior border of the deltoid should be washed with soap and water and dried or cleaned with an ether swab. The Hagedorn needle should be sterilised by heat and allowed to cool. A drop of lymph is placed on the skin, being expressed from the glass tube by a rubber teat, and not blown out by the mouth. The needle is held at an angle of 45° with the skin and the side of the point of the needle is pressed through the drop of lymph with sufficient force to indent the skin and enter its superficial layers, but not to draw blood. This pressure movement is repeated 30 times for revaccination and also for a primary vaccination when it is urgent or obligatory. For non-urgent primary vaccination 10 pressures are satisfactory. Alternatively vaccination may be made by a single linear scratch about half an inch (12.5 mm.) long through a drop of lymph. The scratch should be sufficiently deep to leave a red mark, but not to draw blood. Primary vaccination in infants requires no dressing before the fifth or sixth day, when a loose application of sterile gauze should be applied. A special dressing can be obtained for adults which protects the crust and allows free passage of air, so that the lesion quickly heals. The vaccination should be inspected on the seventh day. If a primary vaccination "takes," a papule forms on the third day, which is vesicular by the fifth day, continues to enlarge until the eighth day and matures, becoming pustular by the tenth day. The vesicle dries and forms a scab, which separates between the fourteenth and twenty-first days. The skin around the vesicle is red and swollen during the second week and the axillary lymph nodes are usually enlarged. A scar results which shows small depressions or foveations. During the second week there is usually malaise and some pyrexia.

able that he is suffering from small-pox. If a successful test vaccination is made on the second day of illness, small-pox is practically excluded.

Course and Complications. The course of a case of average severity has been described above. Confluent or hæmorrhagic cases are much more severe and usually rapidly fatal. The complications include laryngitis, bronchitis, bronchopneumonia, heart failure, conjunctivitis, corneal ulceration, panophthalmitis, otitis media, mastoiditis, orchitis, bedsores, boils, encephalomyelitis, neuritis and osteomyelitis.

Prognosis. This varies with the protection afforded by previous vaccination and the type of disease. The most critical days are usually the twelfth to the fourteenth. If the initial fever is slight the prognosis is usually good, but the converse is not true.

Treatment. *Prophylactic.* Primary vaccination is most successful between the third and sixth months. Primary vaccination at school age is discouraged owing to the risk of encephalomyelitis. Vaccination successfully performed in infancy affords protection for about 7 years. It should be repeated at the ages of 7, 14 and 21, and again if there is an epidemic. Chicken-pox should be made notifiable during an epidemic of small-pox. The patient's house and its contents should be disinfected. *Quarantine period.* Contacts should be vaccinated and kept under observation for 16 days. Marboran (33T57) given by mouth has been shown to have prophylactic value. The dose is 1.5 to 3 G. as a syrup b.i.d. p.c. for 4 days. Anti-vaccinal gamma-globulin is also efficacious. Mass vaccination has little value in controlling an outbreak. *Isolation period.* The patient must be removed to, and kept in an isolation hospital until all the scabs have separated and the skin has healed, usually for 6 weeks or longer.

Curative. The patient is kept in bed in a well-ventilated room and bright light is excluded. Benzylpenicillin should be given at the onset of the disease, 500,000 units (300 mg.) being injected intramuscularly every 12 hours. Diet: Milk and fluids are given during the febrile period of the disease, the diet being rapidly increased when the temperature falls. Toilet: The hair should be cut short and the skin sponged twice daily with warm water. A freshly prepared saturated solution of potassium permanganate should be applied all over the skin on beginning treatment; this can be repeated in a day or so with a 1% solution. Warm baths, to which potassium permanganate is added to make a pale pink colour, are welcomed after the pocks have burst. The virus is destroyed by 1 in 10,000 permanganate. The face should be covered with a lint mask soaked in iced water and covered with oiled silk. The offensive odour can be mitigated by dabbing the skin with 1 in 100 carbolic acid solution instead of the permanganate. The eyelids should be smeared with petroleum jelly and the eyes frequently bathed with boracic lotion. If any eruption appears inside the lids they should be everted and treated with petroleum jelly containing hydrarg. oxid. flav. 8 gr. (0.5 G.) and atrophin. sulph. 16 gr. (1 G.) to the oz. (30 G.). If there are signs of further inflammation, a drop of Albuclid Soluble should be instilled into the eyes every 4 hours, and local heat applied frequently.

jaw can only be opened slightly, owing to pain. Trismus may be noted and salivation is usually increased. More rarely the submaxillary or sublingual glands alone are affected, and here, too, there is usually a bilateral spread. When the parotid is involved the orifice of the parotid duct in the mouth is usually seen to be swollen. Rarely the lacrimal glands enlarge. The spleen may be just palpable. The temperature rises usually to 101°F . (38.3°C .) or over and takes 3 or 4 days before it reaches normal. With complications such as orchitis or pancreatitis it rises again. Occasionally orchitis, pancreatitis or benign aseptic meningitis may occur without parotitis. The pulse is usually slow, 50 to 60. The blood: There is a lymphocytosis, the average figure being 48%, and the total white cell count is increased. The urine: Proteinuria occurs in about one-third of cases. The cerebrospinal fluid: An excess of lymphocytes and of globulin is frequently found, apart from meningitis.

Differential Diagnosis. This is not usually difficult. If the parotid is enlarged other causes such as sarcoidosis, sepsis, drugs such as iodides, tumours and Mikulicz's disease must be excluded. The lungs should be X-rayed in suspected sarcoidosis to see if any characteristic changes are present (see p. 609). Septic parotitis is usually unilateral and often suppurates. In Mikulicz's disease the parotid enlargement is chronic, painless and the lacrimal glands are also affected. Enlarged cervical lymph nodes must also be excluded, such as those due to diphtheria, or glandular fever. In a case of mumps in which salivary glands other than the parotid are involved, the glands are usually affected bilaterally in a day or so. The lymphocytosis in mumps also aids in the diagnosis. The mumps complement fixation test is positive.

Course and Complications. The swelling in mumps usually disappears in less than a week and the glands practically never suppurate. The most frequent complication is orchitis, which is however rare before puberty. It occurs usually about the seventh day or later; generally only one testis is affected. Hydrocele and oedema of the scrotum may also develop. In females tenderness may occur over the ovary. Other complications include myocarditis, acute pancreatitis as evidenced by epigastric pain, vomiting and constipation and a high serum amylase content, mastitis, otitis media, labyrinthitis and nerve deafness, peripheral neuritis, and neuritis of the II, VII, VIII and III cranial nerves. Meningo-encephalitis, meningism or meningitis may occur at any stage in the illness. An aseptic meningitis occurs in about 50% of cases.

Prognosis. This is very good. Permanent sterility, but rarely impotence, may result from orchitis; permanent deafness or diabetes mellitus are rare sequelæ.

Treatment. *Prophylactic.* It is very doubtful whether convalescent serum or gamma-globulin has any prophylactic or curative effect in mumps. *Quarantine period:* This is 26 days, but children may attend school for the first week. *Isolation period:* The patient should be isolated for a week after all swelling has gone from the glands, and for a minimum of 14 days.

Curative: The patient should be in bed for 10 days, as the

Vaccination "takes" less each time and often not at all after the third time. Immunity appears about the tenth day after vaccination. Vaccination is contraindicated in the presence of any chronic skin lesion such as eczema, in acute infections, or if the child has recently been exposed to an infectious disease.

Complications. These include : 1. Sepsis : The arm may become red and brawny and very painful ; the axillary lymph nodes enlarge and the temperature is raised. 2. Generalised vaccinia : This may be due to (a) auto-inoculation by scratching, the vesicles occurring elsewhere, as on the face ; (b) blood-borne infection, generalised papules and vesicles forming between the fourth and tenth days. 3. Protein rashes : Various erythemata may occur. 4. Osteitis. 5. Encephalomyelitis : A dread but rare complication proving fatal in about 35% of cases ; it has been specially noted since 1923, and occurs usually in children and young adults who have not been previously vaccinated. It is possibly due to a dormant virus activated by the vaccine virus. The symptoms are noted about the tenth or twelfth day after vaccination. The patient is drowsy, complains of headache, vomits, and becomes delirious with various pareses. Post-mortem there is perivascular demyelination in the brain and cord. Treatment consists in the injection into a vein or into the spinal subarachnoid space of 5 to 30 ml. of serum taken from an individual who has been successfully vaccinated 14 days previously. Between 1942 and 1962 109 deaths due to vaccination occurred in Great Britain.

Mumps (*Epidemic Parotitis*)

Definition. An acute infectious disease characterised by enlargement of the salivary glands, usually the parotids.

Etiology. The virus is present in the saliva and spread by droplets. By some it is considered to be neurotropic, the nervous system being primarily involved with secondary affection of the salivary glands, by others it is thought to be a septicæmia, the virus having a predilection for the salivary glands. The patient is considered to be infectious for 2 or 3 days before the swelling appears. *Predisposing causes* : 1. Age : 5 to 15 years and again 18 to 25 years. 2. Sex : Chiefly males. 3. Season : Winter and spring. 4. Absence of a previous attack : Second attacks are rare. 5. Overcrowding in army huts. Epidemics occur all over the world.

Pathology. The parotid swelling is chiefly due to hyperæmia and cedema of the connective tissue. Fibrosis of the testis with atrophy of the glandular epithelium may occur. The pancreas may be hyperæmic.

Incubation Period. 12 to 23 days, usually 18 days.

Clinical Findings. The patient is usually a boy or young adult, who complains of headache, malaise, sore throat, nose bleeding or stiff neck, before he notices the pain and swelling in one parotid region. Often, however, the parotid swelling is the first symptom.

On Examination : Some fulness is seen behind the angle of the jaw ; this spreads forward over the masseter and down into the neck and the parotid rapidly becomes definitely enlarged. In a day or so the opposite gland is usually affected, the skin becomes tense over the gland and the

convalescent stage : After about 4 to 6 weeks the whoop disappears, and the cough gradually lessens, although it may still be provoked by running or sea-bathing. The leucocyte count has now returned to normal.

Differential Diagnosis. Whooping-cough must be diagnosed from other catarrhal infections such as a cold, the early stages of measles and laryngeal diphtheria, from paroxysmal coughs due to tracheo-bronchitis or enlarged bronchial lymph nodes, which in children may be tuberculous, and from other causes of mediastinal pressure in adults. If there is no whoop the diagnosis depends upon the character of the cough, the blood count and isolation of the bacillus from droplets or sputum.

Course and Complications. The usual course is as described above. The most important complications are : Bronchitis, bronchopneumonia, pulmonary collapse from blockage of a bronchus with mucus, encephalitis, convulsions and cerebral hæmorrhage. Other complications include spasm of the glottis, bronchiolectasis, acute emphysema, surgical emphysema, spontaneous pneumothorax, otitis media, prolonged vomiting, bleeding from the nose, ears, eyes and gums. The cough may provoke hernia or prolapse of the rectum. Bronchiectasis or tuberculosis may develop later.

Prognosis. The disease is serious in very young infants, in debilitated and rickety children, and in association with convulsions and bronchopneumonia. In an uncomplicated case the severity may be gauged by the number of paroxysms, any figure over 20 in the 24 hours being grave. The outlook is bad where there is inability to retain food, or when there are frequent convulsions.

Treatment. *Prophylactic* : Infants should be immunised against whooping-cough (see p. 502). Gamma-globulin prepared from hyper-immune serum, 2.5 to 5 ml. intramuscularly, will afford temporary immunity to an unvaccinated contact. *Quarantine period* : This is 3 weeks. *Isolation period* : This is 6 weeks.

Curative : The patient should be in bed during the catarrhal stage and until the vomiting becomes infrequent. The room should be well ventilated but maintained at a temperature of 60° F. (15.5° C.). Diet : Liquids and semi-solids are advisable until the paroxysms lessen. When vomiting is severe the feeds should be given about 10 minutes after the vomit, as this offers the best chance of the nourishment being retained. Dextrose, 60 gr. (4 G.) should be given t.i.d. to prevent acidosis. Discharges and sputum should be burnt. Tetracycline (Achromycin) may be given for a week in doses advised for bronchopneumonia (see p. 158). An inhalation of tnc. benzoin. co. 60 m. (4 ml.) to 1 pint (600 ml.) of steaming water often relieves catarrh. For the cough a sedative mixture containing Tnc. opii camph. 5 m. (0.3 ml.), tnc. ipecac. 3 m. (0.2 ml.), syr. pruni serot. 10 m. (0.6 ml.), aq. chlorof. ad 120 m. (8 ml.) should be given six-hourly for a child of 5. If the respiration rate is raised the child should be nursed in an oxygen tent. If the paroxysms still continue a rectal injection of ether 60 m. (4 ml.) and olive oil $\frac{1}{2}$ fl. oz. (15 ml.) may be given twice daily, or phenobarbitone, 1/24 gr. (2.5 mg.) t.i.d. in milk for

recumbent position lessens the liability to orchitis. Fluid diet is required until mastication is painless. Mouth washes should be used frequently such as glycerin. thymol. co. (B.P.C.). Glycerin. belladon. (B.P.C.) should be painted over the swollen glands and fomentations applied if there is much pain. For orchitis the affected testicle is supported with a suspensory bandage or small pillow, and glycerin. belladon. (B.P.C.) with fomentations are applied. An intramuscular injection of corticotrophin (ACTH gel), 100 units, on two successive days may relieve the pain. Operation is not required for pancreatitis.

Whooping-Cough (*Pertussis*)

Definition. An acute infectious disease characterised by paroxysms of coughing followed by an inspiratory whoop.

Etiology. Whooping-cough is caused by the *Hæmophilus pertussis* (Bordet-Gengou bacillus). *Predisposing causes:* 1. Age: Chiefly children between 2 and 5 years, but adults are affected. 2. Sex: Females predominate slightly. 3. Season: March and April especially. The disease is spread by droplet infection, rarely by fomites or a third person. It is most infectious in the catarrhal stages. Second attacks may occur.

Pathology. Whooping-cough is rarely fatal apart from complications such as bronchopneumonia. The trachea, larynx and bronchi show catarrhal changes and the bronchial lymph nodes are enlarged. The bacillus is found especially in the larynx and trachea.

Incubation Period. 6 to 18 days, usually 7 days.

Clinical Findings. *The catarrhal stage:* The patient is generally a child, who first shows the symptoms of a severe cold and a little cough. The temperature is slightly raised, 99° to 100° F. (37.2° to 37.8° C.). The blood: There is a leucocytosis of 12,000 to 27,000 per c.mm. with 60% or more lymphocytes. If the patient coughs over a blood-agar potato plate the *H. pertussis* can often be isolated. The organism may also be isolated by pernasal or postnasal swabbing. The former method is the more satisfactory. *The paroxysmal stage:* This begins about 5 to 14 days later. It is characterised by a noisy, rapidly repeated, explosive cough, during which the child is cyanosed, tears may run from the eyes, and mucus from the nose. This is immediately followed by a long-drawn crowing inspiration or whoop. The attacks tend to be provoked by feeding, by exertion or emotions, but they also occur at night. After the attack the child may drop asleep. She is often alarmed by the paroxysm and may get out of bed or run to her mother. Vomiting may occur at the end of the attack and the patient may lose weight. In the intervals the conjunctivæ tend to be congested, and the face a little swollen, ulceration of the frænum linguæ may be seen, due to friction against the teeth during the attacks. The temperature is usually normal. The blood still shows a leucocytosis. The urine may contain an excess of uric acid.

In some cases the attack is mild or abortive, and although paroxysms of barking cough occur by day and night, there is no whoop. *The*

may reach 102° to 103° F. (38.9° to 39.4° C.) (see Fig. 60). The pulse is relatively slow, 90 to 100, and often dicrotic. The abdomen is a little swollen, owing to flatulence, and there may be gurgling on palpation over the cæcum. The abdominal reflex is usually absent. The spleen is just palpable. Typhoid spots (rose spots) may appear about the seventh day, pink maculo-papules, 2 to 4 mm. in diameter, fading on pressure and situated on the trunk and abdomen. They are not numerous, perhaps 6 to 12, they disappear in 2 to 4 days, and fresh crops appear. There is often a little bronchitis. The blood: There is leucopenia, 4,000 to 5,000 white cells per c.mm. At times there is a slight leucocytosis during the first week. Typhoid bacilli are present. The urine: Febrile proteinuria may occur. Typhoid bacilli may be present at the end of the week, but more often not until the second week. The motions may be costive or loose ("pea-soup"), yellowish and offensive. Typhoid bacilli may be present, but they are found in a higher percentage of cases in the second and third weeks. During this time there may be swelling of the aggregated lymphatic follicles.

Second Week (Fastigium). This stage has largely been abolished by the use of chloramphenicol. The patient is more prostrated, the headache is less marked and deafness may develop. The tongue is drier and coated in the centre, with a clean tip and edges. Insomnia may now be troublesome and delirium occur. The temperature remains sustained at about 101° to 103° F. (38.3° to 39.4° C.), and the pulse accelerates a little to just over 100. The blood: The Widal reaction becomes positive after the tenth day; typhoid bacilli are usually present. The bowels: There is a greater tendency to diarrhoea during this period. During this week sloughs may form in the aggregated lymphatic follicles.

The Third Week. (Defervescence). The patient is still more exhausted and may sink into the "typhoid-state" with delirium, muscular twitching, coma-vigil, a dry and shiny tongue and sordes on the lips. This stage of wasting is seldom seen now as adequate nourishment is supplied. It is the danger period, owing to the risk of hæmorrhage or perforation. During this week the intestinal sloughs may separate. Usually there is, however, improvement towards the end of this week and the temperature begins to fall by lysis; rarely by crisis. The abdomen may be more distended by meteorism, and the patient is often much wasted.

The Fourth Week. (Convalescence). The temperature gradually falls to normal in the mornings, rising a little in the evenings. The abdominal reflex reappears, the spleen is no longer palpable, and the general condition improves. During this week repair takes place in the areas where the sloughs have separated. Recrudescences may occur, the temperature rising irregularly, but the spleen does not enlarge and no fresh spots appear. *Relapses:* After the temperature has been normal for about a week, it may rise again in step-ladder form and the disease be repeated, with fresh spots, enlargement of the spleen and intestinal symptoms. The duration of the relapse is usually shorter than that of the original disease. *Varieties:* 1. *Mild* (including "ambulant"

an infant. Gamma-globulin obtained from hyperimmune serum may be injected intramuscularly, in doses of 2.5 to 5 ml. on four successive days. Convulsions in an infant should be treated with hot baths, lumbar puncture, inhalations of chloroform, the rectal injection of pot. brom. 6 gr. (0.36 G.) in water 1 fl. oz. (30 ml.), or the subcutaneous injection of $\frac{1}{8}$ to $\frac{1}{16}$ gr. (7.5 to 3.5 mg.) of sodium phenobarbitone.

Typhoid Fever

(Enteric Fever)

Definition. An acute infective disease characterised by continued fever, enlargement of the spleen, bacillæmia, involvement of intestinal lymphatic tissue and usually a roseolar eruption.

Etiology. Typhoid fever is caused by the *Salmonella typhi*. *Pre-disposing causes* : 1. Age : Chiefly between 5 and 35 years. 2. Sex : Slight excess of males. 3. Season : Chiefly the autumn. 4. Overcrowding : Especially in tents in the army. 5. Bad sanitation. 6. Absence of a previous attack or recent inoculation. The disease occurs all over the world. It is spread by patients and carriers, through contamination of food and water, especially milk, cream, butter, oysters, ice-cream, watercress and canned meat; it is also spread by flies (their feet, vomit and excreta), by fomites, and by inhalation of bacilli, as from dried excreta. The nurse in charge of a patient may contract typhoid fever by the latter method. Epidemics are usually due to a carrier contaminating the food supply of an area, owing to bacilli on his fingers soiled with urine or fæces, or to sewage contamination of drinking water.

Pathology. Infection probably spreads from the bowel to the blood; the organisms are then excreted by the bowel or kidneys. The bacilli tend to lodge in the gall-bladder and intestinal lymphoid tissue, and they may be found in the cutaneous spots. Intestinal lesions include swelling of the aggregated lymphatic follicles (Peyer's patches) and of the solitary lymphatic follicles; the last 18 inches (45 cm.) of the ileum are chiefly involved. These areas may ulcerate and perforate. The spleen is enlarged and soft, the mesenteric lymph nodes are enlarged, the skeletal muscles may undergo Zenker's degeneration.

Incubation Period. 7 to 21 days, usually 14 days.

Clinical Findings. The onset is usually insidious, the patient complaining of lassitude, frontal headache, backache, constipation, anorexia, epistaxis, malaise and insomnia associated with a gradually rising temperature. In some cases there is a sudden onset with fever, vomiting, rigors, and delirium. As the disease runs an average course of 4 weeks, the main features during each week will be considered.

First Week. (Invasion stage or advance.) The patient may be up (ambulatory typhoid), the face is a little flushed and the tongue has a white fur with the edges and tip clean. The pupils are dilated. There may be complaint of abdominal pains or discomfort. The temperature rises in a step-ladder fashion with a progressive evening rise, and it drops $\frac{1}{2}$ to 1° F. (0.9° to 1.8° C.) each morning. In this way by the end of the week it

bladder. The patient's expression becomes drawn and anxious. The effect on the temperature varies ; it may or may not fall. The pulse is more frequent. There is some limitation of abdominal movement with respiration, the abdomen may be a little more swollen, tenderness and rigidity may be present and the patient usually lies with the legs drawn up. Venous thrombosis : The left femoral vein is usually affected, often in the fourth week. Respiratory : (a) Laryngitis or ulceration of laryngeal cartilages. (b) Bronchitis. (c) Pneumonia, in the third week or later, or at the onset (pneumo-typhoid) : (d) Pleural effusions. Cardiac : (a) Myocardial degeneration. (b) Endocarditis and pericarditis are rare. Neuritis, especially causing the " tender toes."

Other complications include : Otitis and parotitis, which are not rare, meningitis, cerebral thrombosis or embolus, myelitis, nephritis, typhoid spine (thickening of the intervertebral discs ; it usually occurs late in the disease and the pain is very severe), periostitis, boils, acute cholecystitis, infarction of the spleen and suppuration of the mesenteric lymph nodes. " White leg," following venous thrombosis, or gall-stones may result as sequelæ of typhoid fever.

Prognosis. This has been much improved by the use of chloramphenicol, and the mortality rate has probably fallen to about 1%.

Treatment. Prophylactic. The disease is preventable. Contacts and all exposed to infection should be inoculated, inoculation does not increase the risk of infection. A mixed vaccine (T.A.B.C.) containing 1,000 millions typhoid and 500 millions paratyphoid, A, B and C in 1 ml., is used. 0.5 ml. is first given, and after 10 days 1 ml. is injected subcutaneously. This vaccine may be combined with 1 ml. of tetanus toxoid in each dose and repeated at an interval of 1 month. Active pulmonary tuberculosis is a contra-indication. The immunity conferred lasts about 2 years. In an epidemic, water and milk should be boiled and carriers sought for. There is no medical treatment which will inevitably cure a chronic carrier. The carrier state has been abolished in a few cases by giving 200,000 units (120 mg.) of benzylpenicillin every 2 hours for 6 to 8 days, together with sulphathiazole 1 G. by mouth every 3 hours. Chloramphenicol (Chloromycetin) does not appear to affect the carrier state. Ampicillin (Penbritin) four 250 mg. capsules 6-hourly for 3 months, may prove effective, but there is a risk of sensitization. In some cases cholecystectomy has been successful. All cases must be notified. **Isolation period.** The patient must be isolated for about 5 to 6 weeks, and on discharge the faeces and urine should be free from typhoid bacilli on six successive examinations on alternate days. Should the patient continue to excrete typhoid bacilli after 3 months, he becomes a carrier. A positive Vi. agglutination does not indicate that the individual is a carrier.

Curation. The patient is put to bed and kept there until the temperature has been normal for 2 weeks. The course of the disease has been much modified by the use of chloramphenicol. The organism disappears from the blood within 24 hours, and the patient becomes convalescent in a few days. The value of highly skilled nursing is therefore much diminished. The nurse should wear gloves while attending to the

cases). 2. *Apyrexial*. 3. *Severe*. (a) *Hæmorrhagic*. (b) *Pneumotypoid*, the disease starts with lobar consolidation of the lung. (c) *Nephro-typoid*, the onset is with symptoms of acute nephritis. (d) *Meningo-typoid*, the onset is with symptoms of meningitis.

Differential Diagnosis. At the onset typhoid fever may be mistaken for influenza, gastro-enteritis, pneumonia, nephritis or meningitis. The

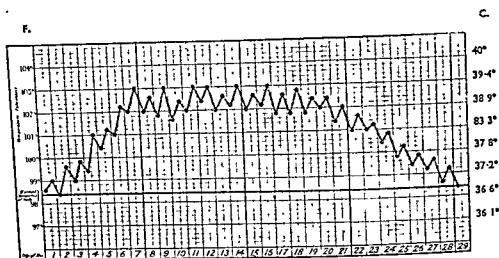


FIG. 60. TEMPERATURE CHART IN TYPHOID FEVER.

temperature should always be taken, as ambulant cases will then be kept under observation when found to be pyrexial. The continued fever may be confused with that due to paratyphoid fever, tuberculous peritonitis, miliary tuberculosis, pyelitis, undulant fever, bacterial endocarditis, or Hodgkin's disease. Typhus fever and secondary syphilis have also caused errors of diagnosis. A typical clinical picture is not always present, and reliance must be placed on blood and faeces culture and the Widal test. A person inoculated with T.A.B. vaccine will give a positive Widal reaction for a year or more, but if an active typhoid infection supervenes the agglutinin titre of the serum usually waxes and wanes during the course of the disease. Virulent strains of typhoid bacilli contain two varieties of somatic antigens, O. and Vi.; the third antigen, H., which is flagellar, is not an indication of active infection. These antigens give rise to corresponding agglutinins in the serum. Agglutination of the H. form is probably indicative of previous inoculation, whereas O. agglutination signifies active infection.

Course and Complications. The typical course has been described above, together with the recrudescences and relapses which ensue at times. The most important complications are:—Intestinal: (a) *Hæmorrhage*. Especially during the third week. The temperature falls, the pulse becomes rapid and feeble, there is pallor, and air hunger may ensue. Blood is seen in the motions in varying amounts. (b) *Perforation and peritonitis*. These are likely to occur at the end of the third week, especially in the ambulant patient. There is abdominal pain, which may be referred to the tip of the penis, owing to the contiguity of the

These organisms can be identified by cultural and agglutination reactions. Para. A is rare in England, but Para. B occurs fairly often. Para. C is met with chiefly in the Eastern Mediterranean area. The diseases are spread in the same way as typhoid, by contact, carriers and infection of food; but contaminated water does not appear to be so frequently incriminated. Chinese frozen whole eggs appeared to be the source of two outbreaks of Para. B epidemics in England in 1955 and in 1961 a small epidemic occurred in England due to infected raw dessicated coconut. Paratyphoid fever, as opposed to typhoid fever, can also be transmitted from animals to man.

Clinically paratyphoid fevers may begin comparatively suddenly, with shivering and pyrexia, but the diseases are usually less severe and of shorter duration than typhoid fever, and ulceration of the intestines is less liable to occur. The colon is ulcerated in some cases and the causative organism is more likely to be found in the faeces than it is in typhoid fever. The temperature curve is more irregular. A respiratory type of paratyphoid is described with bronchitis or pneumonia, in which paratyphoid bacilli are present in the sputum, and a septicæmic type with high remittent fever, pneumonia, arthritis, meningitis, pyelonephritis, endocarditis, cholecystitis or pelvic abscesses. The treatment is identical with that of typhoid fever (see p. 587). Successful treatment of a carrier has been recorded by the intramuscular injection of B.R.L. 1060, 500 mg. 6-hourly for 2 weeks.

Brucellosis

(*Undulant Fever. Malta Fever. Abortus Fever*)

Definition. A disease due to a specific micro-organism and conveyed by milk.

Etiology. The *Brucella* group of organisms includes the *Br. melitensis* infecting goats and sheep, the *Br. abortus* of bovines and the *Br. suis* of swine. In Great Britain only bovines are infected, in America swine are also infected. Both *Brucella* groups may cause undulant fever in man. Milk is the chief source of infection in Great Britain. Cream is a less common source of infection, and butter and cheese are doubtful sources. Veterinary surgeons and farmers may be infected through the skin while looking after parturient cows. Malta fever is usually contracted through drinking goats' milk. Water may be contaminated from goats and the disease may also be transmitted through cheese. The disease occurs in almost every part of the world. **Predisposing causes:** Sex: Males predominate possibly because of an occupational incidence. Age: 15 to 45.

Pathology. The brucella lodges in the cells of the reticulo-endothelial system, especially in the lymph nodes, liver, spleen and bone marrow. Small granulomata are formed. Caseation does not occur but there may be suppuration. The testis, ovary, or meninges may be affected.

Incubation Period. 5 to 30 days, usually 2 to 4 weeks.

Clinical Findings. The patient is gradually taken ill with malaise,

patient and wash her hands well in soap and water, and afterwards rinse them in 1/2,000 perchloride of mercury. Diet : Patients undoubtedly do better when given an adequate dietary of 2,000 to 3,000 calories, which prevents tissue waste. The patient should drink enough fluid to prevent water depletion. A check should also be kept on the electrolyte balance (see Chapter VI).

The mouth should be cleansed after each feed with a swab dipped in glycerin and lemon. The bowels : The stools should be examined daily for undigested food, or blood or membrane. If there is constipation an enema may be given on alternate days, or liq. magnes. bicarb. 1 fl. oz. (30 ml.) by mouth. If there is diarrhoea a starch and opium enema containing starch 60 gr. (4 G.), water 2 fl. oz. (60 ml.) and tnc. opii 30 m. (2 ml.) should be administered. Meteorism is likely to occur if too much milk is given. For its relief turpentine stupes can be applied to the abdomen, the flannels being wrung out in water containing ol. terebinthin. 60 m. (4 ml.) in 2 pints (1.2 litre) of water. If the temperature rises above 104° F. (40° C.) it should be lowered 2°F. (3.6°C.) by tepid sponging. Chloramphenicol is the most effective remedy, but there is a small risk of marrow aplasia. The dose is 1.5 G. b.i.d. for 4 days, 0.5 G. t.i.d. for a week, then 1 G. daily for 2 to 3 days. Ampicillin (Penbritin) is more expensive and may cause sensitization reactions. The dose is 500 mg. 6-hourly until the temperature settles, and then 250 mg. 6-hourly for 10 days. Despite the normal temperature the risk of hæmorrhage and perforation remains during the third week.

Complications should be treated as follows :

Hæmorrhage : No food should be taken for 24 hours. An injection of morphin. sulph $\frac{1}{4}$ gr. (15 mg.) should be given. If the bleeding persists a starch and opium enema should be administered. If the patient is very exsanguinated he should receive a drip blood transfusion. An enema should be given if the bowels have not moved in 4 days, after a preliminary rectal injection of 4 fl. oz. (120 ml.) of warm olive oil.

Perforation : Operation has a high mortality rate, treatment with large doses of chloramphenicol and the Ochsner-Sherren regime gives better results.

General instructions : The urine should be mixed with an equal volume of 1/20 carbolic acid and allowed to stand covered over for 2 hours before being thrown into the drain. The fæces cannot be adequately sterilised by clinical disinfectants, but should be mixed with an equal quantity of 1/20 carbolic acid for 2 hours. Where the water carriage system is not perfect they should be mixed with paraffin and sawdust and burnt. Sheets should be changed directly they are soiled with excreta and put into a bucket containing 1 in 40 carbolic acid for 6 hours. Fly-papers should be hung in the sick room.

The Paratyphoid Fevers

Paratyphoid fevers bear a close resemblance clinically and bacteriologically to typhoid fever ; they are caused by the *Salmonella paratyphi* A, B or C.

intervals. Pains may be relieved by aspirin 10 gr. (0.6 G.) t.d.s. as required. If the temperature is above 103° F. (39.4° C.) it should be lowered 2° F. (1.1° C.) by tepid sponging. Tetracycline (Achromycin), 0.5 G. for an adult, may be given every 6 hours for 3 weeks. A second course should be given if relapse occurs. In the more severe cases, especially those infected with *Br. melitensis* or *Br. suis*, intramuscular injections of streptomycin 1 G. should be given every 12 hours for a week, followed by 0.5 G. every 12 hours for 2 weeks. The urine and faeces should be disinfected as for typhoid fever.

Typhus Fever

(Spotted Fever)

Definition. An acute infectious disease characterised by fever, a typical rash, profound toxæmia and nervous symptoms.

Etiology. Typhus fever is caused by *Rickettsia prowazeki*, oval filter-passing organisms. These are found in the patient (internal organs) and in lice (*pediculi corporis* and also *capitis*) which transmit the disease. Typhus fever is spread by lice, either by their bites or by their excreta being scratched into the skin. The louse does not become infective for 6 to 7 days after biting a patient with typhus. Murine typhus is caused by the *Rickettsia mooseri* and is transmitted by the rat flea. Scrub typhus is described on p. 753. **Predisposing causes:** 1. Under-nutrition and famine. 2. Dirt and over-crowding. 3. Season: Winter and spring. 4. Age and sex: All ages and both sexes are affected. 5. Locality: It is more common in Eastern than in Western Europe. It occurs in North and Central Asia, North Africa, and near the Andes in South America. It is unknown in the tropics except at great altitudes. It occurs endemically and in epidemics. Brill's disease is probably a recrudescent form of louse-borne typhus. Tabardillo, which occurs in Mexico, is louse-borne typhus.

Pathology. Typhus nodules are found microscopically post-mortem in the skin, brain and other organs. They are due to localised necrosis and dilatation of small vessels. The spleen is enlarged and soft, and petechiae may be seen in various mucous membranes.

Incubation Period. 5 to 21 days, usually 12 to 14 days.

Clinical Findings. There may be a prodromal period, with malaise, for a few days. The patient is usually suddenly taken ill with frontal or occipital headache, pains in the back and limbs, shivering, nausea, or rarely vomiting.

On Examination: The patient is flushed and looks rather drowsy; the eyes are congested and the tongue coated. The temperature is raised to about 100° F. (37.8° C.). The course of this disease has been considerably modified by immunisation and by the use of chloramphenicol and chlortetracycline (Aurcomycin). The following description is that of an un-immunised case not treated by these antibiotics.

The rash appears on the fourth or fifth day, first as a "subcuticular mottling," the spots being under the skin, and later papules develop. These are rose-pink, fading on pressure and resemble typhoid spots.

headache and pain in the back and limbs. The onset may be sudden with a rigor. Pains may also be felt in the jaws, eyeballs or testicles. In some cases the throat is sore and swallowing is painful.

On Examination : The most striking feature is the continued fever. The temperature usually rises irregularly and remains remittent for 1 to 4 weeks. After falling to normal, the temperature may rise again in one or two days, but the second wave is generally shorter than the first. The temperature may then settle to normal with an occasional rise to 99° F. (37.2° C.), or for a prolonged period, such as 8 months, irregular rises may occur. The pulse is usually slow, about 80. There is often marked sweating in the early morning, and transient painful swellings may occur in the joints. The bowels tend to be constipated. The spleen is palpable in some cases. Less frequently the liver and lymph nodes may be enlarged. Epistaxis may occur late in the disease. A vesicular eruption may be seen on the palate. The blood: There is leucopenia with a relative lymphocytosis of about 50%, and some anaemia. The agglutination test is usually first positive between the sixth and fourteenth days. An agglutination in a dilution of 1/80 is considered to be diagnostic. Often agglutination in a dilution of 1/1,000 or more is obtained. The blood culture is often positive, but the organism may not grow for 19 days or longer, under anaerobic conditions. *Varieties :* Mild attacks probably frequently pass unnoticed. A severe septicæmic form is also described.

Differential Diagnosis. The disease must be distinguished from other causes of prolonged fever, sweating, and joint pains, such as enterica infections, tuberculosis, malaria, septic infections, rheumatic fever and influenza. The diagnosis rests upon the agglutination test, the leucopenia, and the isolation of the organism from the blood. There is also an intradermal test performed by injecting 0.1 ml. of brucellin. With a positive reaction an oedematous area with surrounding erythema, 2 to 6 cm. in diameter, appears in 4 to 48 hours. This is an indication that the patient has had a brucella infection in the past, or has one at the time of the test.

Course and Complications. As described above, the course is characterised by a tendency to relapse, and so it is difficult to say when the disease is cured. In some cases the disease lasts only a few days, in others for many years. Complications include bronchitis, orchitis, abortion, mastitis, parotitis, arthritis and pains in the extremities.

Prognosis. The mortality rate is 2 to 3%, and the disease is often serious owing to the tendency to prolonged invalidism.

Treatment. Prophylactic. Only pasteurised or boiled milk should be drunk. The treatment of infected cows is still undecided. Living non-virulent vaccines are usually administered to check the abortion, but there is a risk that the cows will then become chronic carriers, eliminating the organisms in their milk.

Curative. The patient should be put to bed and a mild aperient given. The diet should be liquid during the pyrexial waves, such as boiled or pasteurised milk, dextrose orangeade, barley water and meat extracts, but nourishment should be increased during the apyrexial

Treatment. Prophylactic. Good protection is obtained by the vaccine, prepared by growing the *Rickettsia prowazeki* in the yolk sac of chicken embryos. Three doses of 1 ml. are given at weekly intervals. Freedom from lice is all-important. Native populations should be deloused by D.D.T. (dichlor-diphenyl-trichlorethane) powder during epidemics. **Quarantine period.** Contacts should be deloused and quarantined for 15 days. **Isolation period.** The patient should be isolated for 5 weeks.

Curative. The patient should be taken to an isolation hospital, his clothes removed and deloused by D.D.T. powder, the axillary and pubic hair shaved, the head closely clipped and treated with sassafras lotion, ol. sassafras. (B.P.C.) $\frac{1}{2}$ fl. oz. (22.5 ml.), ol. amygdal. 60 m. (4 ml.), with a stiff brush to destroy nits, and bathed in soap and water. The attendants should have their hair and persons protected from lice by caps, overalls and D.D.T. powder, and they should wear rubber gloves. Chlortetracycline (Aurcomycin) or chloramphenicol (Chloromycetin) should be given in doses of 1 G. hourly for 3 doses, followed by 0.5 to 1.5 G. 6 hourly. This should be continued for 48 hours after the temperature is normal. The mouth should be cleaned after feeds with glycerin and borax. Circulatory shock may require treatment by transfusion of plasma, or saline and glucose. For restlessness or insomnia phenobarbitone 1 gr. (60 mg.) may be given by mouth, or hyoscin. hydrobrom. 1/200 gr. (0.3 mg.) injected subcutaneously. Nikethamide (Coramine) 2 ml. may be injected subcutaneously 4 hourly.

Q Fever

Definition. An acute febrile illness often accompanied by pneumonitis due to a Rickettsial infection. The name Q fever was originally chosen by Derrick, who first described it in 1937 in Queensland, "until a fuller knowledge should allow a better name." It has subsequently been recognised in Europe, Africa and America.

Etiology. The causative organism is the *Rickettsia burneti*. Human beings are infected by occupational exposure to dairy cattle, and by drinking raw milk from infected cows. The *R. burneti* has been found in the bandicoot, a small Australian bush animal, and in various ticks.

Pathology. Rickettsiae may be isolated from the lungs, spleen, testes, brain and kidneys. The microscopical appearance of the lungs resembles that found in psittacosis or in the virus pneumonias.

Incubation Period. 12 to 15 days.

Clinical Findings. The disease has a sudden onset, the temperature rising to 103° or 104° F. (39.4° or 40° C.). It may fall to normal once or twice in the 24 hours. The pulse is slow, and in severe cases there are rigors and heavy sweats. Prostration, delirium and coma have been described. There is severe occipital and retro-orbital headache and generalised muscular aching. In a few days a dry irritating cough appears, and a little bloodstained sputum may be expectorated.

On Examination: Small areas of high-pitched bronchial breathing

They enlarge, become darker, brownish and do not fade on pressure. Small petechiæ may be seen between the spots. The whole rash is called a "mulberry" rash. It appears first on the trunk and spreads to the limbs, the face is usually exempt, but is red and swollen. The rash fades during the second week and leaves some staining. It does not appear in crops. The skin emits a peculiar mousy odour. The temperature: This usually rises irregularly during the first 4 days to about 103° F. (39.4° C.), there is then a continued fever for about a week, when the crisis occurs about the tenth or fourteenth day. The fall is critical but may take 2 to 3 days before normal is reached. The pulse increases in rate with the rise in temperature. The respirations are usually increased to about 20 per minute. The blood: There is a leucocytosis, with excess of monocytes (up to 15%). A special agglutination is given by the serum, called the Weil-Felix reaction. The serum agglutinates *B. proteus*, strain OX19. It is often found that by the end of the first week the titre reaches 1/200, and by the end of the second week 1/1,000 or more. A rising titre is characteristic of an active infection. The slide test is often positive by the end of the first week. A drop of blood is mixed with a loopful of methylene blue coloured proteus OX19 suspension on a slide. Agglutination is shown by the formation of blue aggregates visible to the naked eye. The cerebrospinal fluid is clear, but may contain an excess of globulin and leucocytes.

The general condition throughout the febrile period is one of extreme prostration; an excited delirium may occur during the first week, followed by "coma-vigil" in the second week, in which the patient lies semi-conscious with eyes partially open and muscles twitching. The patient may be tortured by fearful delusions. The pupils are usually small and the knee-jerks are absent, the tongue becomes dry, black and cracked. The bowels are often constipated early and diarrhoea may occur in the second week; thirst is marked and there may be some deafness; the spleen is usually just palpable. In a favourable case, when the temperature falls, the condition rapidly improves.

Varieties. 1. *Mild typhus.* 2. *Severe or blasting typhus (Typhus siderans)*, which is rapidly fatal. 3. *Typhus sine eruptione* may occur, in which the Weil-Felix test is positive.

Differential Diagnosis. Typhus is very rare in England, and when an isolated case occurs it is most likely to be mistaken for typhoid fever or measles. Other conditions which may require exclusion are: Influenza, cerebrospinal fever, malignant malaria, encephalitis, purpura, relapsing fever or uræmia. The marked prostration, typical rash and Weil-Felix reaction serve to differentiate typhus.

Course and Complications. A relapse is extremely rare, but a second attack may occur. Complications include: Laryngitis, bronchitis, myocardial degeneration, venous thrombosis, otitis media and nephritis. Permanent mental deterioration, inability to concentrate or headaches may be sequelæ.

Prognosis. Typhus fever is a serious disease, and the mortality increases with the age of the patient. The outlook has, however, been much improved by the use of antibiotics.

an operation or childbirth. There is usually a sudden onset with shivering, headache, malaise, and at times vomiting and a sore throat. A burning sensation is then felt on a certain area of the skin.

On Examination: A bright red patch is seen, with a definite raised margin. This spreads and the skin becomes tense and shiny, and vesicles or blebs containing yellowish fluid may form on the red area. This fluid usually does not contain streptococci.

Facial erysipelas usually begins near the nose or inner canthus of the eye. The face may become very bloated and the eyelids so œdematous that the patient cannot see; the ears also become red and tense, and the tongue is very furred. The tissues are at this stage very painful on pressure, and the skin feels tightly stretched. The lymph nodes in the neck are enlarged. Headache, insomnia and noisy delirium may be troublesome.

Erysipelas may spread from one part of the skin to another (wandering erysipelas), or the lesion may first appear at such sites as the back, around the umbilicus in newborn infants, around the vulva during the puerperium, and around any operation wound which is usually a "clean" one. The fauces may be red and swollen (faucial erysipelas) or the mucous membrane of the nose affected. The temperature rises rapidly to 103° or 104° F. (39.4° or 40° C.), but usually falls quickly with penicillin treatment. The blood shows a polymorphonuclear leucoeytosis. The urine usually contains protein. When the rash fades it is followed by desquamation.

Differential Diagnosis. Erysipelas must be diagnosed from simple inflammations. In the latter there is not a raised, red edge, and the central part of the inflamed area is more angry-looking than the periphery. The constitutional disturbance is not as great.

Course and Complications. Relapse may develop after the temperature has been normal for a day or so, or several months later. Complications include septicæmia, subcutaneous abscesses and bronchopneumonia.

Prognosis. Erysipelas is frequently mild, but the outlook is more serious in an alcoholic, in the new-born and in the aged.

Treatment. The patient should be kept in bed until the temperature is normal and the lesion healed. Procaine penicillin, 300,000 units, should be injected intramuscularly every 12 hours for 5 to 7 days. The temperature usually falls to normal in 48 hours.

The affected skin may be covered with lint soaked in a cold saturated solution of magnesium sulphate. The eyes should be washed out with boric lotion and a drop of sulphacetamide sodium (Albucid), 10%, instilled every 4 hours if they become inflamed.

with fine râles may be heard in the lungs. Occasionally there is a lobar consolidation, pleural friction or pleural exudation. The spleen may be palpable and there may be hepatomegaly with slight jaundice. There is no rash, as occurs with other Rickettsial infections. X-ray examination of the lungs shows patchy, rather uniform shadows, which may persist after the patient has apparently recovered. The temperature often falls to normal after a week, but it may persist for 3 to 4 weeks. There is usually no anæmia and the white cell count is often normal, although there may be a relative or absolute lymphocytosis. The Rickettsiæ may be found in the blood, less often in the urine. The serum taken on the twelfth and twentieth days usually shows an increase in agglutination titre of from 1 in 4 to 1 in 20, with rickettsial emulsions.

Differential Diagnosis. Most cases in this country are probably mistaken for virus pneumonia. Derrick considered the possibility of typhus fever, undulant fever, typhoid and paratyphoid fever, leptospirosis and influenza. Diagnosis is established by the agglutination test which may rise to 1 in 80, and by finding the causative organism in the blood or urine. In epidemics the source may be traced to the milk supplied from a special farm, although the infected cows appear healthy.

Prognosis. The death rate is about 1 in 500.

Treatment. Chlortetracycline (Aureomycin) should be given in doses similar to those for typhus fever (see p. 593). The response is often rapid and dramatic, the temperature quickly falling to normal, the headache disappearing, and the patient feeling well and asking to get up.

Chronic Q Fever

This resembles subacute bacterial endocarditis. *R. bruneti* has been isolated from heart valves.

Erysipelas

Definition. An acute infective disease characterised by fever and a typical inflammation of the skin.

Etiology. Erysipelas is due to infection with different types of group A hæmolytic streptococci. *Predisposing causes*: 1. Alcoholism. 2. General debility and defective sanitation. 3. Season: Autumn and winter. 4. A previous attack: Recurrences are very common. 5. Age: It occurs in new-born infants and subsequently chiefly between the ages of 20 and 60.

The organisms enter the skin through a minute abrasion or through operation wounds or birth injuries (puerperal erysipelas). They are conveyed by direct contact or by contaminated hands or instruments, or the infection may occur apparently independently.

Pathology. The organisms are found chiefly in the lymphatics at the edges of the inflamed area of skin, and spread to the subcutaneous tissues may cause suppuration. Toxæmia is often severe.

Incubation Period. 2 to 3 days or longer.

Clinical Findings. The patient, who is usually an adult, may give a history of some trivial injury to the face, or may be recovering from

Congenital Syphilis

Clinical Findings. A history is often obtained that the mother has had a series of miscarriages or still-births before a living child is born. At birth the infant may be normal in appearance, or small. The skin may be sallow (*café au lait*), the face old-looking, and the cry rather squeaking. A bullous or pustular eruption may be present at birth. The various manifestations of congenital syphilis are best classified under the age periods at which they are likely to appear :

At Birth. Much hair on the head (syphilitic mop). Aged appearance. Bullous rash (syphilitic pemphigus), especially on the palms and soles. White pneumonia (due to fibrosis of the lungs).

Three to Four Weeks. Syphilitic roseola, especially around the buttocks ; "snuffles" due to rhinitis ; otitis media. Choroiditis and iritis. Paroxysmal hæmoglobinuria.

Three to Four Months. Epiphysitis, causing apparent paralysis of limbs (pseudo-paresis). Rhagades (fissures) at the angles of the mouth, which leave radiating scars on healing. Condylomata in the perineum or under the arms. Enlargement of the spleen and liver. Gumma of the testicle.

Six to Twelve Months. Iritis. Bossing of the skull on the frontal and parietal bones (Parrot's nodes or hot-cross bun appearance) and cranio-tabes (softened areas of bone in the skull) are probably rickety changes.

Second Year. Dactylitis, the phalanges of the fingers or toes being swollen. Depression of the bridge of the nose (saddle-bridge). Hydrocephalus and idiocy.

Childhood and Later. Keratitis, especially between 6 and 12 years. The teeth : The central permanent upper incisors are notched at the cutting edge, which is narrower than the base, and the teeth are spaced (Hutchinson's teeth). The first permanent molars may be dome-shaped, owing to failure of development of the central portion of the crown (Moon's teeth). Deafness may occur suddenly from gummatous destruction of the internal ear. Periostitis. The tibiae become curved forwards and thickened (sabre tibia). Painless swelling of joints, such as the knee (hydrarthrosis). Nervous lesions may be manifest, such as dementia, juvenile tabes or general paralysis. Diabetes insipidus may result from a basal syphilitic meningitis. The blood Wassermann reaction is usually positive up to puberty, but may become spontaneously negative later in life.

The cerebrospinal fluid. This shows changes characteristic of syphilis (see p. 417) in about 40% of cases, depending upon whether the central nervous system is involved.

Differential Diagnosis. Hutchinson's diagnostic triad is of value in childhood ; the stigmata are interstitial keratitis, the typical incisor teeth and deafness. In infants a napkin rash must not be mistaken for a syphilitic roseola. The history, appearances of the child and positive Wassermann reaction of the child and its mother are usually diagnostic.

Course and Complications. The victim of congenital syphilis may

CHAPTER IX

INFECTIOUS DISEASES OF KNOWN AND DOUBTFUL ETIOLOGY

Syphills

Definition. A venereal and general disease caused by a specific protozoon.

Etiology. The causative agent is the *Treponema pallidum* (*Spirochaeta pallida*). Infection is usually by direct transmission in sexual intercourse. The primary sore and secondary lesions, such as condylomata, are very infectious, and the treponemes may also be present in the saliva and urine in the secondary stage. Localised gummata, such as may occur in the throat, are also sources of infection. Syphilis less often results from other causes, as by contact with an infected article such as a cup or a pipe, or the primary lesion may occur on a doctor's examining finger (*syphilis innocens*). The disease may be transmitted by an infected mother to her offspring (congenital syphilis). The organisms usually enter through an abrasion in a mucous membrane.

Pathology. The initial lesion is the primary sore or chancre. The treponemes pass to the neighbouring lymph nodes and rapid dissemination by the blood stream ensues, probably as soon as, or even before, the chancre is visible. The primary sore is usually genital, but extragenital chancres may occur on the lip, tonsil, tongue, breast, finger and elsewhere. The secondary stage is the clinical manifestation of generalisation of infection; lymph nodes are enlarged, especially the posterior cervical, axillary and supratrochlear. Various rashes occur due to reactions around cutaneous blood vessels. The kidneys may show evidence of nephrosis. Gumma formation is the characteristic feature of the tertiary stage, the gumma being a granuloma which is comparatively avascular. It may occur in the skin, the heart or lungs, the liver, the central nervous system, bones, and in other tissues. The arteries are especially affected in syphilis, there being early, a round-celled infiltration of the adventitia. The inflammatory change spreads inwards along the vasa vasorum to the media, where rupture of elastic fibres occurs. In the aorta this predisposes to aneurysm. The mouths of the coronary arteries are constricted, but the vessels themselves are unaffected. Endarteritis obliterans may occur in the smaller vessels. Treponemes are most numerous in the primary sore and the neighbouring lymph nodes; they occur in the blood, cerebrospinal fluid, and in the cutaneous lesions; they are most scanty in the tertiary lesions, but lie dormant there, being sheltered from blood-borne spirochaetocidal drugs, owing to the interferences with the blood supply.

Congenital Syphilis

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Course and Complications. The victim of congenital syphilis may

be very slightly or very severely affected. Fresh manifestations are liable to show themselves in late childhood or early adolescence, as mentioned above. Usually the child grows up, but is often stunted, and the intelligence may be below normal. Secondary infections are liable to occur.

Prognosis. This depends upon the intensity of the infection and the organs affected. The virulence usually diminishes in proportion to the length of time the mother has been infected.

Treatment. Prophylactic. The mother should be given a course of anti-syphilitic treatment before or during pregnancy. This consists of the intramuscular injection of 600,000 units of a procaine penicillin daily for 14 days. In every subsequent pregnancy the procaine penicillin is repeated for 14 days.

Curative. Congenital syphilis in an infant or child is treated by the daily intramuscular injection of 800,000 units of a procaine penicillin for 14 days. Four such courses are given during a period of 2 years. Interstitial keratitis should be treated by an ophthalmologist.

Acquired Syphilis

Incubation Period. This is usually about 28 days, probably never less than 10 days, but it may be prolonged to 12 or 13 weeks.

Clinical Findings. Primary Stage. The patient gives a history that about 4 weeks after sexual intercourse he noticed a small red spot on the penis. This enlarged, but was painless and gradually formed a sore.

On Examination: The sore has an indurated cartilaginous feeling (hard or Hunterian chancre) after 2 to 3 weeks. Serum exudes from it on slight scarification, and this serum is teeming with treponemes. The chancre may be within the meatus of the urethra, or at other sites as mentioned on p. 596. If untreated the chancre heals in about 6 to 8 weeks, leaving a scar. The neighbouring lymph nodes enlarge, and treponemes are found in the fluid obtained by lymph node puncture. The lymph nodes may suppurate if there is a mixed infection, constituting a bubo. In about another fortnight enlargement of lymph nodes is also noted at the back of the neck, under the arms and in the supratrochlear regions. The blood Wassermann reaction becomes positive about 8 weeks after infection, and changes in the protein and cell contents of the cerebrospinal fluid are usually present.

The Secondary Stage. This is noted about 4 weeks or later (up to 6 months) after the appearance of the primary sore, and is characterised by systemic disturbance, as shown by headache, sore throat, anaemia, skin rashes, generalised lymph node enlargement and at times by nephrosis. The patient may also complain of pains in the limbs due to synovitis or periostitis. Various rashes may occur; the syphilitic roseola is ham-coloured or brownish, and is seen on the trunk and extremities. Brownish pigmentation with areas of leucoderma may develop on the neck, especially in dark-haired patients. Papulo-pustular or scaly eruptions may also appear on the body and limbs, the epithelium may become heaped up in a conical mass, forming rupia. Soft warty excre-

scences or condylomata are apt to form on moist surfaces which are not kept clean, as around the anal margin, vulva and under the breasts. The throat may be very red, and "snail-track" greyish-white streaks may be seen on the fauces or soft palate, and ulceration of the tonsils. White mucous patches may occur inside the cheeks. Alopecia of a general or patchy type is liable to occur. Chronic laryngitis may be present. Jaundice may develop with an enlarged liver, or in a severe form with acute necrosis. The blood: There is anaemia, treponemes may be present, and the Wassermann reaction is positive. The cerebrospinal fluid: The Wassermann reaction is often positive, and other changes, such as excess of globulin, increase of lymphocytes and a characteristic colloidal gold curve (Lange's test) may be present (see Fig. 20).

Tertiary Stage. This stage may emerge directly from the preceding one, or be separated from it by an interval of many years. It is characterised by the formation of gummata. The gummata may appear in various parts of the body: In the skin and subcutaneous tissues as ulcerating nodules which separate, leaving punched-out ulcers, and on healing form thin paper-like scars; in muscles, forming painless swellings, which eventually ulcerate; and in bones, causing severe pains, usually intensified at night. Gummata may also form in internal organs such as the liver, the testis, lungs, pituitary and the adrenal. The heart may be involved, the gumma giving rise to disturbances of conduction according to its situation, or to localised myocardial degeneration. Syphilitic arterial changes give rise to cardio-vascular or renal degeneration. The various neurological diseases, such as general paralysis, tabes dorsalis, cerebral gumma, meningitis and meningo-myelitis, are described in the chapter on nervous diseases. The alimentary tract may be affected. Glossitis, leukoplakia, localised gumma or ulceration may occur in the tongue. There may be ulceration of the tonsils or gumma formation in the œsophagus, less frequently in the stomach. Iritis and otitis may also be seen as tertiary manifestations. A prolonged continued temperature lasting for several weeks is met with at times during the tertiary stage. The various results produced by tertiary syphilis are more fully considered in the chapters dealing with the heart, lungs, alimentary tract, etc.

Differential Diagnosis. In the primary stage the diagnosis should be established by finding treponemes in the serum from the chancre, and treatment should not be delayed until the blood Wassermann reaction becomes positive. Chaneroid, herpetic and scabietic lesions may cause confusion. In the later stages the diagnosis is usually established by the Wassermann reaction of the blood and the cerebrospinal fluid. Combined lesions may occur, such as an epithelioma of the tongue in a patient who is also a victim of syphilis. A positive Wassermann reaction may also be found during the pyrexial stage of malaria, although the patient is not suffering from syphilis, and it has been recorded in other diseases, such as scarlet fever, typhus fever, yaws, systemic lupus erythematosus, etc.

Course and Complications. The disease usually pursues a very chronic course, and the treponemes are apt to lie dormant in various

parts of the body, shut off from the blood stream. Later they give rise to severe reactions in the form of tertiary lesions.

Prognosis. Syphilis is a very serious disease, and it is impossible to say in any individual case what course it will pursue. A mild initial lesion may be followed years later by crippling cardiac complications or fatal nervous affections. Efficient treatment in the earliest stages holds out the best hope of a permanent cure.

Treatment. Prophylactic. Avoidance of irregular sexual intercourse is the best preventive. Apart from this, protection is afforded by the use of a condom or sheath during intercourse and the immediate washing of the genitalia in soap and water after intercourse. The patient should not marry for 2 years from the beginning of the treatment, and his Wassermann reaction should be negative.

Curative. As soon as the chancre appears and the diagnosis is established by finding treponemes in the smear, a course of treatment should be instituted. The patient must not take any alcohol, and if feverish he should be in bed. Procaine penicillin in oil containing 2% aluminium monostearate (PAM) should be injected intramuscularly daily in doses of 600,000 units for 14 days. During the first year the blood Wassermann reaction is determined every 3 months, and every 6 months during the second and third years. The cerebrospinal fluid is examined at the end of the second year. If there is a relapse the treatment is repeated.

For late syphilis, including the latent form and the tertiary manifestations, 600,000 units of a procaine penicillin are injected intramuscularly daily for 4 weeks. After 6 months the penicillin course is repeated. Further courses are given during the next 2 years if the serological and clinical findings are not satisfactory.

The Jarisch-Herxheimer Reaction. This may result from penicillin treatment. It may occur on the day after the first or second injection. It is probably due to an increased activity around the site of the lesions, caused by liberation of toxins from the treponemes destroyed. Thus the rash may be more marked and the Wassermann reaction become more strongly positive. If the lesions are cardiac, laryngeal or cerebral, very grave results may ensue from vascular changes in the affected areas, such as heart failure, laryngeal obstruction or paralysis. To prevent these reactions the initial dose of penicillin should be small (see p. 414).

Gonorrhœa

Definition. A venereal disease caused by infection with a specific micrococcus.

Etiology. The cause is the *Neisseria gonorrhœa* (gonococcus). Infection in man is usually by sexual intercourse. Infants may have their eyes infected at birth if the mother is suffering from the disease. Gonorrhœal vaginitis of children may become epidemic in institutions, due to infected towels or clothes.

Pathology. The gonococcus penetrates mucous membranes, such as line the urethra or vagina. It may spread directly to the uterus,

uterine tubes, peritoneum, the greater vestibular glands (glands of Bartholin), prostate, seminal vesicles, bladder, pelvis of the kidney, or rectum. It may be carried by the blood stream to the heart, meninges, joints, muscles, tendons or eyes. The toxins may cause such lesions as peripheral neuritis, keratoderma or iritis. Infection may be conveyed by the finger to the eyes, causing ophthalmia.

Incubation Period. This is usually from 8 to 10 days.

Clinical Findings. Acute gonorrhœa is characterised by acute urethritis, and in the female also by cervicitis and vaginitis. The secondary complications, which were formerly so common, are likely not to occur with early penicillin treatment. They included: Acute arthritis, meningitis or myelitis, pericarditis, endocarditis and myocarditis, peripheral neuritis and septicæmia.

Gonorrhœal Arthritis. The patient is usually a young adult of either sex who may be suffering from an attack of acute gonorrhœa, or who may have been infected previously. He is suddenly taken ill with malaise and pain in one or more joints. Often one joint only is affected, such as the knee, ankle, wrist, shoulder or elbow, or the pain may be localised to the sterno-clavicular, temporo-mandibular, spinal or sacro-iliac joints.

On Examination: The affected joint, if one of the large ones, is swollen, tender, and the skin over it may be slightly red and hot; effusion is present in the joint and movement is painful. There is also constitutional disturbance, for the tongue is furred and the temperature and pulse rate are raised. Fluid aspirated from the joint is sero-fibrinous and may contain gonococci. In women there is usually a vaginal discharge, and in men a urethral discharge may be present before or after prostatic massage. A swab taken from the cervix uteri or from the urethra after prostatic massage often shows gonococci.

Varieties. Chronic hydrarthrosis, which is painless and insidious in onset, may occur, or subacute polyarthritis.

Differential Diagnosis. The commonest error is to diagnose the condition as acute rheumatism, or some other variety of acute infective arthritis. The characteristic features are the history of gonorrhœa, which, however, is often not forthcoming, the special joints affected, the presence of gonococci in the genito-urinary discharge, a positive complement fixation test, and the response to specific treatment. Salicylates fail to give relief.

Course and Complications. The joints usually recover with proper treatment, but stiffness may persist for long periods. A chronic, painless arthritis, with effusion, may ensue in some cases.

Prognosis. This is generally good.

Treatment. If the case is seen early a single injection of 600,000 units of procaine penicillin with 200,000 units (120 mg.) of benzyl-penicillin usually effects a cure. If "gleet" persists after adequate penicillin treatment it is due to non-specific urethritis and should be treated with chlortetracycline (Aureomycin). For gonorrhœal arthritis 600,000 units of penicillin should be injected every 12 hours for 5 to 10 days. For vulvovaginitis and for secondary complications the penicillin

should be followed by a course of sulphathiazole. Suppurative periadenitis of the greater vestibular glands requires aspiration of the pus and subsequent injection of 100,000 units (60 mg.) of benzylpenicillin. The dose of sulphathiazole for an adult is 4 G., followed by 2 G. 6 hours later. Subsequently, 1 G. is given every 6 hours until a total amount of 80 G. has been taken. The urine should be kept alkaline by a potassium citrate mixture, 5 to 6 pints (3 to 3.6 litres) of fluid being taken every 24 hours. In all cases the blood Wassermann reaction should be determined at the end of 2 and 6 months.

Influenza (La Grippe)

Definition. An acute infectious disease characterised by fever, prostration, a great liability to pulmonary complications and to epidemic incidence.

Etiology. The *Hæmophilus influenzae* (Pfeiffer's bacillus) is not usually accepted as the cause of influenza, and its rôle is uncertain, although it is frequently found in the sputum in all types of the disease. *H. influenzae* is accepted as the cause of influenzal meningitis. Three viruses have been found in influenza, A, B and C, but in many cases no virus can be detected. Virus A was described in 1933 when it was found that garglings from influenza patients would produce a transmissible disease in the ferret. It is more virulent than Virus B, several strains exist and it is liable to cause epidemics every two years. Virus B, discovered in 1940, differs from A in its antigenic properties. Virus C was discovered in 1949. Influenza tends to be endemic and to cause epidemics every 4 or 5 years, of a comparatively mild type. The majority of wide-spread epidemics have been associated with virus A infection. During an epidemic it may be impossible to isolate a virus from as many as 75% of the cases which are clinically typical examples of influenza. Pneumonic complications are probably less common in B infections. Streptococci, pneumococci and staphylococci are probably secondarily infecting organisms. The cause of pandemic influenza, the most important variety, has not been shown to be a virus, and remains uncertain. *Predisposing causes:* Nothing is known on this score except that the disease tends to occur in pandemics about every 10 to 40 years, and in epidemics about every 33 weeks. In the 1889 pandemic infants and old people were affected, whereas in the 1918 pestilence young adults in the prime of life were the victims. It is estimated that 20 million deaths occurred in this pandemic, 6 millions dying in India in 2 months. Three waves were noted in the last two pandemics, the second one being the most serious. The disease spreads with great rapidity.

Pathology. Post-mortem the changes resemble those of a hæmorrhagic septicæmia, but the spleen is not enlarged. Hæmorrhages may be seen in the sheath of the rectus abdominalis and in the muscle itself. The pericardium may contain a little blood-stained fluid. The trachea shows a typical pink colour of its lining membrane between the

rings, especially in the lower part. The bronchi contain muco-pus. Exudation may be seen in the bronchioles and alveoli, which prevent proper aeration of the blood. Hæmorrhagic areas of lung tissue, which may float or sink in water, are typical, with patches of collapsed lung. Petechiæ may be seen under the pleuræ; yellow or blood-stained fluid may be found in the pleural sacs. The bronchial lymph nodes are enlarged and may show hæmorrhages. Petechial hæmorrhages are frequent in the mucous membrane of the stomach, and the interior of the ileum, cæcum or pelvic colon may be intensely congested. The kidneys are usually a little enlarged and congested.

Incubation Period. This is probably about 48 hours.

Clinical Findings. The Mild Type. The patient can often say the hour at which he was suddenly taken ill, with lassitude or severe prostration, and at times shivering. Pain may be felt in the head, behind the eyes and on moving the eyes, under the sternum, along the diaphragm attachment, in the back, in the calves or shins and occasionally in other parts of the body. The patient may feel sick, have epistaxis or vomit.

On Examination: The conjunctivæ are often injected ("pink-eye"), the face flushed and the skin dry. The temperature rises rapidly to about 103° F. (39.4° C.) and the pulse is moderately rapid. There is usually cough on the second day and the voice may be hoarse; even in mild cases careful examination of the lungs usually reveals slight abnormalities, such as weak breath sounds at a base, or a few basal râles or some scattered rhonchi. A scarlatiniform rash may occur on the arms, body and legs, but the flexures are usually left clear. The blood shows a leucopenia. The urine usually contains no protein. The temperature falls to normal about the third or fifth day, according to the type of epidemic prevailing, and convalescence is rapidly reached.

Severe Cases. The Bronchopneumonic Type. The onset is similar to that of a mild case, and it is impossible to say in any instance whether the patient will rapidly become dangerously ill. The severe symptoms may be due to an acute toxæmia, the temperature rapidly rising to 104° F. (40° C.) or higher and the patient becoming cyanosed and dying in the course of a few hours. In other cases bronchopneumonia or a severe purulent bronchitis may develop in a few days probably due to a secondary infection. The respirations become rapid and may reach 50 to 60 a minute, but the pulse is not usually proportionately frequent, 110 to 120 being an average rate, and the temperature varies from 100° to 103° F. (37.8° to 39.4° C.) or higher. A peculiar heliotrope cyanosis is typical, in which the face and ears are mauve, but they may be leaden in colour, or the face may be pale, with lips and ears blue. The respirations though rapid are not difficult and there is no orthopnoea. The cough is often troublesome and the sputum is of varying types, being either white and frothy, green and purulent, or tenacious and containing bright red or brown blood. Examination of the lungs often shows very slight signs, but generalised rhonchi may be heard, or there may be small areas of dulcness, with weak breath sounds and crackling râles. The blood is "sticky," the red cells may number 8,000,000 per c.mm.,

and it is difficult to bleed a patient. This is commonly met with in pandemics. There is usually a leucopenia of about 3,000 to 4,000 white cells per c.mm., with about 50 to 60% of polymorphonuclear cells. The urine may contain a trace of protein; a few red and white blood cells are often found and occasionally a hyalo-granular cast. Fatal cases often become delirious towards the end, with low muttering. Patients who recover may complain of attacks of giddiness or profuse sweating during convalescence.

The Gastro-intestinal Type. Other cases, as I frequently observed in the 1918 pandemic, assume a gastro-intestinal form, with vomiting and diarrhoea, and bright blood may be passed in the motions.

Differential Diagnosis. A mild case of influenza is differentiated from an ordinary feverish cold by the greater prostration and muscular pains in the back, limbs and external ocular muscles, and also by its occurrence during an epidemic. It must be distinguished from such diseases as malaria or dengue. The pulmonary varieties would not usually be diagnosed unless occurring in an epidemic, but the heliotrope cyanosis and tendency to hæmorrhages are suggestive.

Course and Complications. The course is very variable, as described above. Complications include: Staphylococcal pneumonia, sterile pleural effusions, empyema, subcutaneous emphysema, herpes facialis, meningitis, sinusitis, otitis media, mastoiditis, jaundice, neuralgia and acute thyroiditis. A latent tuberculous focus in the lungs may be activated, and pulmonary fibrosis or bronchiectasis may ensue. Profuse generalised sweating sometimes follows an attack of influenza and persists for a week or so.

Prognosis. Mild cases recover. Cyanosis is a very grave omen, and cases seldom recover if the respiration rate exceeds 50. Profuse sweating is a very favourable sign in severe cases.

Treatment. Prophylactic. During an epidemic all crowded places should be avoided. The throat should be gargled night and morning with 1 in 4,000 solution of potassium permanganate. Vaccination with an anti-influenzal virus vaccine is of doubtful value. The dose is 1 ml. of a monovalent or mixed A and B virus vaccine. A preliminary desensitising dose of 0.02 ml. should be given as the vaccine contains egg albumin. Attendants on patients should wear a gauze mask.

Curative. The patient should be isolated in bed in an airy room at the first symptom, and remain there until the temperature has been normal for 2 or 3 days in a mild attack. Returning to work too early involves a risk of a serious and perhaps fatal relapse. The bowels should be opened with aperients, if necessary. For the muscle pains and headache aspirin, or tab. codein. co., can be given t.d.s. The diet should be fluid during the fever stage with plenty of bland drinks; over 5 pints (3 litres) a day should be taken to eliminate toxins. Linet. codein. (B.P.C.), 60 m. (4 ml.), may be given t.i.d. to relieve a dry and exhausting cough. If there is severe cyanosis oxygen should be administered continuously through a nasal catheter or mask. For staphylococcal broncho-pneumonia cloxacillin sodium (Orbenin) should be given (see p. 157). There is no specific remedy. The diarrhoea is treated by giving a powder

containing pulv. ipecac. et opii 5 gr. (0.3 G.) and bismuth salicyl. 10 gr. (0.6 G.) three times a day.

During convalescence no strenuous exercise should be taken which might cause the heart to dilate.

Tetanus

(Lockjaw)

Definition. An acute disease, due to a specific bacillus, characterised by violent and painful muscular spasms.

Etiology. Tetanus results from infection with the *Clostridium tetani*, an anaerobic organism, which forms very resistant spores. The bacilli occur in the intestines of animals, such as the horse and cow. Man is infected through a wound being contaminated with soil containing the spores. Catgut used at an operation, bunion pads, court plaster, talc powder, or unbleached cotton wool may contain the spores.

Pathology. The bacilli remain localised, but give rise to very potent exotoxins. These are probably absorbed from the end-plates of motor nerves in the muscles and pass along the nerves to the central nervous system, where they increase the excitability of the synapses. Post-mortem, muscles, such as the rectus abdominalis, may be found ruptured. There are very slight changes seen in the central nervous system.

Incubation Period. This is usually about 12 days. In acute cases it may be as short as 2 days, or it may be prolonged to several months, especially if a prophylactic injection of antitetanic serum has been given.

Clinical Findings. The patient may give a history of a wound when gardening, or there may have been a war wound or a compound fracture, or he may be convalescent from an operation. Tetanus is now more often seen in association with trivial than with severe wounds, owing to the generalised use of antitoxin in the latter. In some cases tetanus appears to arise idiopathically, but the organism then presumably enters the body through an abrasion. In tetanus neonatorum infection occurs through the severed umbilical cord. The patient first notices muscular stiffness, affecting the jaw, neck or extremities. In the course of a few hours the stiffness increases and painful cramps may occur in the affected muscle groups, with dysphagia. In children convulsions may be the first manifestation of the disease.

On Examination: In the early stages no abnormality may be found except an increase of the deep reflexes, such as the knee-jerks. In a developed case the picture is most striking and terrible. The patient has frequently recurring seizures of violent muscular contractions, so that the body may be arched backwards, resting on the occiput and heels (opisthotonus), or bent forwards (emprosthotonus), or twisted sideways (pleurothotonus). The jaw muscles may be firmly contracted (trismus) and contraction of the facial muscles produce the appalling "risus sardonius." Trismus is rarely combined with facial paralysis. Any slight external stimulus such as a noise, a bright light or a touch may provoke an attack. The mind remains clear and the patient may

cry in agony or be unable to articulate owing to spasm of the intercostal and respiratory muscles. The skin is moist or sweating, but the temperature and pulse are usually normal. The temperature may rise to 108° F. (42.4° C.) in the terminal stages, although the patient is free from spasms. The blood: A leucocytosis of about 12,000 per c.mm. may be present. The cerebrospinal fluid is usually normal, but under increased pressure. In local tetanus the spasms are limited to a group of muscles. This occurs especially some months after a bony injury. In cephalic tetanus there is dysphagia and paralysis of cranial nerves, together with generalised convulsions.

Differential Diagnosis. A clue to the diagnosis is usually afforded by the history. Other causes of trismus (see p. 395) must be excluded, and spasms due to strychnine poisoning, meningitis or tetany. In tetanus the muscular spasm does not fully relax between the attacks.

Course and Complications. In fatal cases the spasms become more severe and frequent. Complications include rupture of a muscle and bronchopneumonia.

Prognosis. Early and efficient treatment render the outlook more hopeful, but even then the mortality is usually over 50%. Death may occur in 3 or 4 days from asphyxia or heart failure. The prognosis is usually worse if tetanus rapidly follows the infliction of a wound. Cole calls the "period of onset" the time between the onset of trismus and the first generalised reflex spasms. A period of onset of less than 2 days indicates a very grave prognosis. The prognosis is better with wounds of the lower extremities.

Treatment. Prophylactic. Children should be immunised by the intramuscular injection of adsorbed tetanus toxoid, 3 doses of 0.5 ml., the second dose after 6 weeks, and the third dose 6 months later. Subsequently an injection should be given every 5 years.

In the case of wounds, if it is known that the patient has been actively immunised then tetanus anti-toxin should not be given. The wound should be adequately treated surgically, and either penicillin or tetracycline given for 4 to 7 days. An intramuscular injection of 0.5 ml. adsorbed tetanus toxoid should be given and repeated at the intervals stated above.

If no previous immunisation is known to have been given some authorities state that anti-tetanus serum of equine origin should not be given because it may have a fatal result and because it does not appear to have any special value. Others advise that a single intramuscular injection of 1,500 units should be given into one arm, due precautions being taken against serum reactions (see p. 571), and at the same time an injection of 0.5 ml. adsorbed tetanus toxoid is given into the other arm. It is probably safer to replace anti-tetanus serum by penicillin or tetracycline.

Curative. The patient should be nursed on a water bed in a dark room. A cradle should be used to keep the bedclothes away from his body.

Treatment should be given as detailed above; surgical, antibiotic and anti-tetanic. The adsorbed tetanus toxoid, 0.5 ml., should be

injected at intervals of 5 to 7 days. If there are no reflex spasms phenobarbitone 1 gr. (60 mg.) should be given by mouth every 4 hours. Mental distress and reflex spasm should be relieved by the intravenous injection of thiopentone sodium (Pentothal), in a 2.5% solution. The amount required to produce the required sedation and the frequency of the injections can only be determined by the effect achieved. The needle should be kept in the vein. A muscle-relaxant drug is also required, such as *d*-tubocurarine chloride 30 mg./ml., in an oil and wax base. It is injected intramuscularly in dose of 0.5 to 1 ml. or, if a more rapid effect is required, it is given intravenously in saline, 3 mg./ml. The dose is usually 3 mg./40 lb. (0.2 mg./kg.) body weight. Tracheostomy may be necessary at any moment with intermittent positive pressure respiration.

Actinomycosis

Definition. Specific granulomatous lesions caused by a mycotic organism.

Etiology. The cause is the *Actinomyces bovis* (*Streptothrix actinomyces* or ray fungus). Wolff and Israel showed this to be a strict anaerobe. The aerobic streptothrix of Bostroem, which is found in barley and grasses, is probably non-pathogenic. The so-called actinomycotic lesions in cattle, such as "woody" tongue, and "lumpy" jaw, are usually due to an aerobic organism, the *Actinobacillus lignieresii*, but some of these lesions are due to the *Actinomyces bovis*. Grains and grasses are thought to cause abrasions through which the infecting organisms enter. Man is probably infected by the organism entering damaged mucous or cutaneous surfaces. The most frequent portals of entry are the teeth, tonsils, appendix, and the skin. Males are chiefly affected, between the ages of 20 and 40.

Pathology. The granulomata break down to form abscesses containing little pus, which often discharge through multiple sinuses. Yellowish "sulphur" granules are present in the pus, consisting of a central mycelium and peripheral clubs. The lesions occur most frequently in the head and neck. They may be found in the lungs, pleura or chest wall, in the appendix, caecum, rectum or liver, in the kidneys or female genital tract, or in the skin. A blood borne infection may result in cerebral lesions.

Clinical Findings. The onset is usually insidious, and the findings differ widely according to the site of the lesion.

Cervico-facial Type. This is a surgical condition. Swellings occur in the face, jaw-bone, or neck, which gradually soften with multiple sinus formation.

Thoracic Type. This is described on p. 182. The clinical picture in the early stages may resemble that of bronchitis or of pleurisy; later, an empyema, pulmonary tuberculosis, syphilis or a new growth of the lung may be suggested.

Abdominal Type. The lesion usually spreads from the appendix to the caecum. Secondary liver abscess may develop, or an abdominal

swelling may form resulting in sinuses through the abdominal wall. It is often only detected at an operation for "appendicitis."

Genito-urinary Type. The clinical picture is that of salpingitis or ovaritis, or rarely of a suppurative renal lesion.

Cutaneous Type. The skin and subcutaneous tissues alone may be involved. Possibly infection occurs here from straw.

Nervous Type. Infection may spread from the naso-pharynx, along the olfactory nerves to the brain, causing an isolated lesion near the pituitary or the fornix. Direct spread may occur from the jaw to the base of the brain, or a cerebral abscess or meningitis may follow a pulmonary lesion.

Vertebral Type. The vertebræ may be affected secondarily to a focus elsewhere. Collapse of the body of a vertebra may ensue.

Differential Diagnosis. The condition may closely simulate sarcoma, tuberculosis, or a pyogenic infection. The diagnosis is established by bacteriological examination of the pus; a special request should be made to this effect when the material is sent to the laboratory.

Course and Complications. The course is a chronic one. Complications are rare, and are due to the infection being blood-borne to other sites, such as the liver and brain.

Prognosis. This is favourable in the cutaneous and cervico-facial types, especially if adequate treatment is given early. It is more unfavourable in the deep-seated cases.

Treatment. The pus should be evacuated surgically if possible. Potassium iodide should be given by mouth in gradually increasing doses up to 90 gr. (6 G.) three times a day. The patient is usually tolerant of large doses. Benzylpenicillin should be injected intramuscularly in doses of 4 to 8 million units (2,400 to 4,800 mg.) daily, in divided doses, for about 6 weeks. This may be combined with sulphadimidine. Deep X-ray treatment is of value in some cases.

Sarcoidosis

(Besnier-Boeck-Schaumann Disease)

Definition. Sarcoidosis is a chronic, usually benign, lympho-granulomatosis of widespread distribution in the body.

Etiology. The cause is unknown. The view that sarcoidosis is due to tuberculosis is not generally accepted.

Pathology. Typical granulomata form, consisting of central giant cells, surrounded by epithelial cells, with an outer layer of lymphocytes. Caseation and calcification do not occur. The skin, mucous membranes and most of the organs of the body may be affected.

Clinical Findings. Various types of sarcoidosis are met with according to the location of the lesions. Thus the first symptom may be mistiness of vision due to irido-cyclitis. There may also be enlargement of the parotids, sometimes accompanied by facial palsy. This constitutes the uveoparotid fever of Heerfordt. Hemorrhages may occur in the vitreous, secondary to periphlebitis of retinal veins (Eale's disease).

In other cases the patient complains of vague symptoms of ill health, or, at a routine mass miniature X-ray examination of the chest, bilateral enlargement of the hilar lymph nodes—the so-called “potato glands”—is seen. Other pulmonary abnormalities revealed by X-ray examination include fine mottling, coarse infiltration, fibrosis, collapse and cystic changes.

Erythema nodosum is met with in about one-third of the cases and there may be nodular skin eruptions, especially on the butterfly area of the face, the nose, ears and fingers, which constitute lupus pernio. Bone lesions are found in about 15% of cases, X-ray examination showing punched-out areas of rarefaction in the phalanges, the *osteitis tuberculosa multiplex cystica* of Jüngling. There may also be general atrophy of the bones of the hands and feet. Sarcoid nodules may be found in the tonsils. Hypercalcaemia, with renal failure, is met with in some cases, possibly due to sarcoid lesions in bones. The liver and spleen may be enlarged, and lymph nodes palpable in front of, and behind the ears, in the axillæ, groins, neck and elsewhere. In some cases fever is the most prominent sign of the disease. The sarcoid may invade the heart muscle.

The plasma proteins are often increased, with a reversal of the albumin-globulin ratio, due to increase of globulin. The Mantoux test is usually negative, even to a dilution of 1/100. The Kveim test consists in the intradermal injection of an emulsion of a sarcoid lymph node. A nodule forms at the site of the injection in about 4 to 6 weeks if the test is positive. On biopsy this shows a typical sarcoid lesion. If no superficial lymph node is available for biopsy the diagnosis may be established by liver puncture, the sarcoid being demonstrated in the fragment of tissue removed, even when the liver is not enlarged.

Prognosis. This is usually good, the lesions spontaneously disappearing or healing by fibrosis. When the eyes are affected the outlook is more serious. Pulmonary fibrosis may lead to congestive heart failure. In some cases tuberculosis supervenes. The mortality rate is about 5%.

Treatment. In cases in which the patient's health is affected prednisone should be given by mouth, in doses of 10 to 5 mg. q.i.d. This is gradually reduced as improvement is obtained. Eye lesions should be treated by an ophthalmologist.

Glandular Fever

(Infectious Mononucleosis)

Definition. An acute infectious disease characterised by lymph node enlargement, fever and excess of mononuclear cells in the blood.

Etiology. The cause is unknown. It may be due to an ultra-microscopic filterable virus. *Predisposing causes*: 1. Age: Children and young adults of both sexes are especially affected. 2. Season: It tends to occur in the winter and spring, and there may be small epidemics.

their normal structure, changes closely resembling those seen in lymphatic leukaemia. There is lymphocytic infiltration of the spleen, and rupture sometimes occurs. The liver is frequently enlarged and granulomatous lesions may be found in the bone marrow.

Incubation Period. This is usually 7 to 8 days.

Clinical Findings. The patient is usually a child or young adult, who may not feel well for a few days before being definitely taken ill. He then complains of headache, fever, pain in the neck, and perhaps soreness of the throat and vomiting.

On Examination: Three types are described:—The glandular, the anginose, and the febrile. *The glandular type:* The tongue is furred and the fauces are red. Enlarged lymph nodes may be seen and felt in the neck, and under and behind the sternocleidomastoid muscles. These are usually unilateral, but both sides are affected later. Torticollis may be present for a few days. Enlarged lymph nodes may also be found in the submaxillary region, in front of the ear, in the axillæ and in the groins. They are firm and a little tender, and the patient usually holds the neck rather stiffly. The temperature is raised to about 103° F. (39.4° C.) or over, and the pulse is proportionately rapid. Enlargement of the bronchial lymph nodes may result in a paroxysmal cough, and there may be abdominal pain if the mesenteric lymph nodes are affected. The spleen may be felt in about one-third of the cases. Jaundice rarely occurs, at times during the course of the disease, less often it is the presenting symptom before there is any apparent lymph node enlargement. In the few cases recorded it has usually been obstructive in type, but occasionally the van den Bergh reaction is indirect and bile is present in the fæces. In the latter cases the jaundice cannot be due to pressure of enlarged lymph nodes in the portal fissure. *The anginose type:* A membrane is seen on or near the tonsils, resembling that of diphtheria. The cervical lymph nodes are not as large as in the glandular type. There may be œdema of the neck with considerable local tenderness. The temperature often remains raised for 2 to 3 weeks. *The febrile type:* This affects chiefly adults. A pink maculo-papular rash appears, chiefly on the trunk between the fourth and seventh days. Lymph node enlargement is not usually noted until the end of the third week. Relapses may occur for many months. Various neurological manifestations have been noted, including headache, encephalitis, meningitis, ataxia, coma, convulsions, hemiplegia, ocular and facial palsy, peripheral neuritis and paralysis of the serratus anterior. The cerebrospinal fluid may show a lymphocytosis. The blood: White cells. There is a leucocytosis, of about 20,000 per c.mm.; 80 to 90% are mononuclear cells, either immature lymphocytes, large or small lymphocytes, or large mononuclears. The red cells are not usually affected. In some cases there is no leucocytosis and the mononuclears are not more than about 40%. The blood changes may also be of very short duration. The Wassermann reaction is positive during the second and third weeks in about half the cases. Paul and Bunnell state that the blood serum agglutinates sheep's red cells in a dilution of 1 in 64 by the fourth day of the disease, and that this test is diagnostic. The reaction is usually considered to be positive if

the serum has a titre of 1 in 80 or more after absorption with guinea-pig kidney and shows a reduction in titre of at least two tubes after absorption with ox cells. A positive Paul-Bunnell reaction may also be given in serum sickness, but the heterophile antibody present in these cases can be distinguished from that of glandular fever by absorption tests. Raised transaminase values in the serum (see p. 78) may indicate liver involvement. The urine: Protein and blood may be present.

Differential Diagnosis. Cases which resemble glandular fever clinically but which are seronegative are regarded by some as a different and unnamed disease. Some of these are cases of toxoplasmosis. Glandular fever is differentiated from mumps, as the parotid gland is not involved. Other conditions which have to be excluded are Vincent's angina, diphtheria, leukaemia, Hodgkin's disease, and enlarged lymph nodes due to tuberculosis, syphilis, German measles, typhoid fever or sepsis. The white cell count and lymph node enlargement may suggest acute leukaemia, but the absence of changes in the red cells is of great significance. The cough and blood count may also suggest whooping-cough. Appendicitis may be simulated if the abdominal lymph nodes are affected. The course of the disease usually renders the diagnosis clear. Early jaundice and fever may suggest infectious hepatitis or cholecystitis. In agranulocytic angina there is leucopenia, with over 90% of lymphocytes, and an almost complete absence of granular cells.

Course and Complications. The temperature usually falls to normal in 1 to 2 weeks, but may remain slightly raised in the evening for 6 months; the lymph nodes may remain palpable for several weeks. A relapse may occur about 3 weeks after the onset, with fever and enlargement of lymph nodes. Suppuration is rare. Haemorrhagic nephritis, myocarditis, and rupture of the spleen may occur.

Prognosis. The disease is rarely fatal, although death may occur from bronchopneumonia in the anginose type.

Treatment. The patient should be in bed for 2 weeks; there is no specific treatment. The throat should be swabbed with H_2O_2 (10 vols) and cataplasma kaolini applied to the neck. During the acute febrile stage the patient is kept on a fluid diet, and the bowels should be opened daily. Antibiotics are not of value, but corticosteroids are helpful in anginose cases.

Glanders

(Farcy)

Definition. A specific granuloma, caused by a definite bacillus.

Etiology. Glanders is caused by the *Pseudomonas mallei*. The disease is transmitted to man by direct contact with an infected animal, such as a horse, donkey or mule, the organisms entering an abrasion in the skin or nasal mucous membrane. It may also be conveyed from man to man.

Pathology. The bacilli form an endotoxin, mallein. A granuloma results from the local inoculation, and septicaemia or pyaemia may ensue. The nasal lesions constitute glanders; the subcutaneous nodules

are called "farcy buds" and the enlarged lymphatics "farcy pipes." Abscesses may be found post-mortem in the liver and spleen.

Incubation Period. This varies between 3 days and 3 weeks.

Clinical Findings. *Acute glanders.* The patient is usually a worker amongst horses. He complains of malaise, headache, and at times of nausea and vomiting.

On Examination: The temperature is raised to 101° F. (38.3° C.) or more, and runs an irregular course. The initial lesion may be seen on the hand, arm or face as a papule surrounded by a red area. The lymphatics may stand out as red streaks; a generalised papular or pustular eruption may then appear and abscesses form subcutaneously or intramuscularly. In other cases lesions also occur in the nose and are accompanied by a sticky exudate, ulceration of the nose and enlargement of the cervical lymph nodes. Pneumonic and rheumatic forms of acute glanders are also described. Glanders bacilli may be isolated from the nasal discharge, the abscesses or the sputum. *Chronic glanders.* This is characterised by the appearance of subcutaneous nodules, generally on the forearms, which ulcerate and have a purulent discharge. Constitutional disturbance is slight.

Differential Diagnosis. The diagnosis is suggested by the patient's occupation. The lesions must be differentiated from other granulomata, such as actinomycosis or syphilis, and the generalised pustular eruption, from small-pox. The bacteriological findings establish the diagnosis. Melioidosis, a disease of rats, cats and dogs in Rangoon and Indo-China, occasionally affects man and is very similar to glanders. It is caused by the *P. pseudomallei*.

Course and Complications. Acute glanders is usually fatal in under 2 weeks. Chronic cases may persist for months and then gradually abate, or they may suddenly become acute.

Prognosis. The acute variety is practically always fatal; in the chronic form the outlook is much more favourable.

Treatment. *Prophylactic.* Animals suffering from glanders should be destroyed.

Curative. Some favourable results have been obtained by treatment with sulphadiazine, sulphadimidine and streptomycin. The patient must be isolated and kept in bed, and abscesses opened as they form. Discharges should be disinfected with benzalkonium chloride (Roccal).

Anthrax

(The Malignant Pustule. Wool-sorter's Disease)

Definition. An acute specific infective disease, which may assume a cutaneous, pulmonary or intestinal form.

Etiology. Anthrax is caused by the *Bacillus anthracis*, which forms spores and thus exists for long periods in a viable stage, outside the body. Animals, such as sheep, cattle, goats, horses and reindeer, after eating infected grass, suffer from "splenic fever." Man is infected on the skin (the malignant pustule) by handling infected hides of animals, or by using infected shaving-brushes usually made from horse-hair. The

pulmonary variety of anthrax results from inhaling spores or bacilli in woollen occupations (wool-sorter's disease), and possibly the intestinal form is due to eating infected meat.

Pathology. The organisms are often present in the blood stream, causing a septicæmia; in wool-sorter's disease the bronchial lymph nodes are enlarged, subpleural hæmorrhages may be present, and areas of œdema or collapse are seen in the lungs, with bronchitis. In the intestinal variety hæmorrhagic areas may be seen in the mucous membrane of the bowel, with thrombosis of mesenteric veins. Meningitis may be present as a complication in any septicæmic form of the disease.

The Malignant Pustule

Incubation Period. This is usually less than 24 hours.

Clinical Findings. Infection occurs through an abrasion in the skin. The patient may be a worker in hides, or be infected through a shaving brush. Itching is first noticed on the skin of the face, arm or neck, and a small red papule then appears at the site of the itching, which quickly becomes inflamed and angry-looking. The patient may feel quite well up to within a few hours of his death, or be very ill with malaise, shivering and headache. He suffers little or no pain in the lesion.

On Examination: The papule is seen encircled by whitish vesicles, and in a day or so a black slough forms in the centre. The tissues around become brawny, and the neighbouring lymph nodes enlarge. The temperature may be normal or raised to about 103° F. (39·4° C.). In severe cases the blood culture is positive before death, which occurs in about a week from the onset.

Differential Diagnosis. The malignant pustule must be differentiated from a septic spot or boil, a chancre, or a subcutaneous lesion in glanders. The appearances are very suggestive in anthrax, the history is usually confirmatory and anthrax bacilli are found in the serum from the vesicles. There is never any pus in the "pustule."

Prognosis. The pustule may disappear spontaneously. If the case is treated efficiently within a day or so of its onset the hope of recovery is very good.

Treatment. Prophylactic. All shaving brushes should be free from anthrax spores. A vaccine may be given to those at risk, 3 intramuscular injections of 0·5 ml. at intervals of 6 weeks and 6 months, then one a year.

Curative. The pustule should not be excised, as this increases the risk of septicæmia. It should be covered with gauze to absorb exuding serum, and the affected part of the body kept absolutely still by splints or sandbags. One million units (600 mg.) of benzylpenicillin should be injected intramuscularly, followed by half a million (300 mg.) units six hourly for 4 doses, then b.i.d. for 5 days.

Anthrax Œdema

A diffuse œdema of a limb, the face or body may occur, without any local pustule being seen.

Wool-sorter's Disease

(Pulmonary Anthrax)

Clinical Findings. The patient is usually suddenly taken ill with malaise and shivering, followed by pain in the chest, cough, expectoration and much weakness.

On Examination : The appearances are those of a very severe illness ; the temperature is usually over 103° F. (39.4° C.), the pulse and respirations are rapid. The lungs show signs of generalised bronchitis. The sputum is frothy and blood-stained, and many contain anthrax bacilli. The blood culture is usually positive before death. The disease is usually fatal within a few days.

Treatment. This is as described above.

Intestinal Anthrax

This is a rare variety. The clinical picture resembles that of acute food poisoning, with abdominal pain, vomiting and diarrhoea. The spleen may be palpable, and anthrax bacilli are found in the faeces. It is usually fatal.

Treatment. This is as described above.

Hydrophobia

(Rabies. La Rage. Lyssa)

Definition. A disease caused by the bite of certain rabid animals.

Etiology. The virus is ultramicroscopic and filtrable. It is present in the saliva of mad dogs, cats or wolves. Vampire bats were probably the carriers of the virus in an outbreak in Trinidad. Man is infected by a bite, or by the rabid animal licking a raw surface on his body. The disease is practically non-existent in England now, having been eradicated by the orders for the muzzling of dogs, and later by the quarantine laws which are still enforced, but a case was recorded in 1956 and another in 1964, owing to the speed of travel of the patient from an infected country.

Pathology. Negri bodies are found in the brain of rabid animals. They occur in nerve cells, especially in the hippocampus and cerebellar cortex. They are the inclusion bodies of rabies.

Incubation Period. The average is 6 weeks, but it may vary from 12 days to 8 months or longer.

Clinical Findings. The patient may be a child or adult, who gives a history of being bitten by a rabid animal, usually a dog. The bite heals, but at the end of the incubation period symptoms are noted. The disease falls into three stages : *The invasion.* Irritation or pain is felt at the site of the bite and the patient becomes irritable or depressed and does not feel well. The voice may be a little hoarse. The temperature is found to be slightly raised. *The stage of excitement.* The patient is now acutely ill and in a pitiable condition ; he is very restless, and is seized with painful muscular spasms affecting the muscles of deglutition and respiration. The spasms are provoked by swallowing,

or even by the sight or thought of food or water, or by any sudden stimulus.

On Examination: The temperature is raised to over 101° F. (38.3° C.) and the pulse is frequent. Saliva may run from the mouth, and mucus from the nose; the patient is cyanosed during the spasms, and may be maniacal (*la rage furieuse*). This stage lasts for 2 to 3 days, and then passes into: *The stage of paralysis*. The patient is now exhausted and muscular paralyses develop. The temperature falls, there is unconsciousness, and death from heart failure occurs in a few hours.

Varieties. *La rage muet*. This is rare in man. There is no excitable stage, the patient is quiet and is rapidly paralysed and dies.

Differential Diagnosis. The diagnosis is established by the history of the bite of a rabid animal, the typical clinical findings, and examination of the brain of the animal which shows Negri bodies. If the suspected dog is alive 10 days after the bite, the diagnosis of rabies is excluded. Rabies must be differentiated from:—*Pseudohydrophobia*: This is a hysterical condition occurring after a dog bite. There are no true spasms, but the patient may bark or bite like an animal. *Tetanus* or *strychnine poisoning*: The history here is suggestive, and the muscles of deglutition and respiration are not involved in the manner typical of hydrophobia. *Acute bulbar paralysis*: Here there is no history of a bite, and the maniacal symptoms do not occur. *Acute poliomyelitis*: It may be impossible to differentiate this during life, as in the epidemic in Trinidad in 1931.

Course and Complications. The disease is rapidly fatal, lasting 4 to 5 days, and there are no complications.

Prognosis. Multiple bites are more serious than solitary ones, and bites on the head and face are followed by a more rapid onset than those occurring distally from the central nervous system. Hydrophobia is more likely to follow bites of wolves than those of dogs. The disease is invariably fatal if not checked during the incubation period.

Treatment. *Prophylactic*. The importance of muzzling dogs in endemic zones and of quarantining imported dogs has been mentioned. A dog bite should be allowed to bleed freely, and then washed with 20% soap solution. Deep wounds should be cauterised with fuming nitric acid or pure phenol. Antirabies hyperimmune serum should be injected around the bite, 0.5 mg./kg. bodyweight. The patient may be treated with a vaccine prepared from an attenuated culture of the virus, given daily for 2 weeks. In some cases this has been followed by facial paralysis, myelitis or ascending paralysis.

Curative. Only palliative measures can be employed, such as repeated injections of chlorpromazine (*Largactil*) 50 mg.

Ornithosis (*Psittacosis*)

Definition. An acute infectious disease conveyed by parrots and allied birds and birds of other orders, characterised by fever, prostration, and often by pulmonary symptoms.

Etiology. It is now generally accepted that the disease is due to a filterable virus. Epidemics occur chiefly in houses and flats. In July 1929 there was a fairly extensive epidemic in the Argentine, and cases occurred in England in the autumn and winter of 1929-1930, probably due to parrots imported from South America. Budgerigars (love-birds) may also transmit the disease. In 1934 red cockatoos (galahs) and budgerigars imported from Australia to England were found to be infected. In Germany in 1934 over 150 cases of psittacosis occurred in six months. The source of infection was found to be apparently healthy budgerigars, who are carriers of the virus, the virus probably having been imported into the country by parrots before 1931. The virus is thought to be present in the bird's faeces and beak discharges. Pigeons, canaries, finches, ducks and chickens may also convey the infection. Infection of man is probably through the respiratory tract. Direct infection from man to man is uncommon.

Pathology. The spleen is a little enlarged, red and soft. The lungs: Petechial hæmorrhages may be seen under the pleura, and areas of consolidation occur, which are dull red and dry, with no evidence of suppuration. Microscopically, characteristic "elementary bodies" are found in the hilar lymph nodes, alveolar exudate, Kupffer cells, spleen and lymph nodes.

Incubation Period. This is about 10 days.

Clinical Findings. The patient is usually an adult who gives a history of contact with a parrot or budgerigar which was ill or has subsequently died, or with a budgerigar apparently in good health, which is a carrier of the virus. The onset is somewhat sudden, with malaise, shivering, headache, and at times severe epistaxis, nausea, vomiting or diarrhoea.

On Examination. At the onset the temperature is raised to about 102° to 104° F. (38.9° to 40° C.), but the pulse is slow, under 100. The patient may be drowsy or complain of severe occipital headache. The temperature remains raised for 1 to 3 weeks, and gradually falls by lysis. A cough often appears after a few days, and examination of the lungs shows signs of bronchitis. This may be followed insidiously by the development of areas of consolidation or collapse in the lungs, which disappear as the temperature falls. X-ray examination shows patchy shadows in the lungs. In some instances the patient is overwhelmed with toxæmia, he has a low muttering delirium, and a Parkinsonian-like expression is very obvious. In other cases there is much abdominal distention, with offensive loose motions. Small red spots may appear on the chest or back. The spleen is rarely palpable. The urine often contains protein. The blood: The white cells usually number about 7,000 per c.mm., but in some cases a leucocytosis has been recorded. The blood may contain the virus during the first seven days of the disease, as shown by mouse inoculation. A complement fixation test, using as an antigen 5% virulent mouse spleen in phosphate or saline, is used as a diagnostic test, and a mouse test can also be employed, the animal being infected by the patient's sputum or pleural fluid.

Differential Diagnosis. The disease must be differentiated from

influenza, primary atypical pneumonia, enterica infections, miliary tuberculosis, pneumonia or *E. coli* urinary infection. The onset is more sudden than in typhoid fever. There are neither eye nor limb pains as in influenza. The urine does not contain the colon bacillus. The history of contact with a sick parrot or budgerigar, the presence of the typical clinical picture described above, the demonstration of the virus in the bird or the patient, and the complement fixation test enable the diagnosis to be made.

Course and Complications. The average course is 8 weeks.

Prognosis. The disease is serious, the mortality varying between 10 to 80%. It is worse for old people.

Treatment. Prophylactic. The sick bird should be destroyed by coal gas or chloroform and the carcase burned, taking care that the operator wears rubber gloves, which are also burned. The danger from pigeons and budgerigar carriers still exists in this country.

Curative. The patient should be kept in bed until the temperature has been normal for 4 days. Chlortetracycline (Aurcomycin) should be given in doses of 1 G. every 8 hours for the first 2 days, and then 1 G. every 12 hours for 7 days after clinical recovery.

Coccidiomycosis

Etiology. Coccidiomycosis is caused by the fungus *Coccidioides immitis*. It occurs especially in California, Arizona and Texas. Man is usually infected by inhalation, and at times through the skin.

Pathology. The fungus produces nodules which may form abscesses in the bones, subcutaneous tissues, lungs, liver and spleen, and less often in the kidneys, brain, meninges, peritoneum and pericardium.

Clinical Findings. Mild subclinical cases may occur, but the patient is usually acutely ill with fever and prostration. The symptoms closely resemble those of pulmonary tuberculosis.

On Examination: Signs of bronchopneumonia may be found in the lungs, and thin-walled cavities may form. Skin lesions resembling those of erythema multiforme may appear. These constitute the "Valley fever" or "San Joaquin fever." Dissemination may occur with involvement of bones and internal organs. The causative fungus may be found in the sputum, and the complement fixation test becomes positive.

Prognosis. This varies with the location of the disease. It is good in the primary pulmonary type, but very grave when the disease becomes disseminated.

Treatment. Amphotericin B (Fungizone) may be given as described on p. 184.

years. It has subsequently been found in many places in Europe, and in North and South America, and in other animals, birds and reptiles. In England pigs and sheep have been found to be infected with toxoplasma, and it is estimated that nearly a half of the adult population of England has been infected. The disease may be congenital or acquired, and it is met with clinically in an acute, subacute and chronic stage. In the congenital form the symptoms of the acute illness are due to encephalomyelitis. In other cases there is hepato-splenomegaly, jaundice, pneumonia, myocarditis and skin rashes. There may be neo-natal purpura. Choroido-retinitis is a frequent manifestation which may not be noticed until the child begins to read or until adult life. In the subacute variety there may be progressive encephalomyelitis, hydrocephalus, choroido-retinitis, cerebral calcification of granulomata, and convulsions. Very similar changes are met with in the chronic form. The acquired disease usually manifests itself by symptoms of encephalitis, by febrile exanthematous states associated with pneumonitis or necrotic glomerular lesions in the kidneys, or the infection may be latent. The liver or spleen may be enlarged and swelling of the lymph nodes may suggest a diagnosis of glandular fever. The blood picture may be similar to that in glandular fever. In all active cases the prognosis is very grave.

The diagnosis may be confirmed during life by inoculation of cerebro-spinal fluid, blood or biopsy tissue into mice, by a toxoplasmin skin test, by a complement fixation test, or by a dye test of the serum which inhibits the toxoplasma protozoon from staining with methylene blue.

Treatment. Sulphatriad, 0.5 G. tab., should be given, first 6 tabs. in one dose, followed by 2 tabs. four hourly for 2 weeks. At the same time pyrimethamine (Daraprim), 25 mg. tab. should be given. First 2 tabs. then 6 hours later 1 tab., 6 hours later 1 tab., then 1 tab. daily for 14 days in all. A watch should be kept on the platelet counts.

Histoplasmosis

This disease is caused by a fungus, the *Histoplasma capsulatum*. Man is infected by the inhalation or ingestion of the spores. They are found in man intracellularly in the cells of the reticulo-endothelial system, in the lungs, the sputum, the blood, the bone marrow, etc. It resembles coccidiomycosis in appearing as a mild or primary form, or in a severe disseminated form. It is endemic in the valleys of the Mississippi and Ohio rivers, in the St. Lawrence area, in Mexico and Panama. It has also been met with in South America, Australia and Northern Europe.

In the acute pulmonary form the signs and symptoms resemble those of diffuse pneumonitis. In only a few cases does the disseminated variety occur. There is then often fever, diarrhoea, enlargement of lymph nodes and of the spleen and liver, and destruction of the adrenals. The nervous system may also be involved. Involvement of the bone marrow causes anaemia and leucopenia. Lesions may also occur in the skin, the tongue, the larynx, etc. The histoplasmin skin test, performed by injecting intradermally 0.1 ml. of a 1/1,000 dilution of histoplasmin

solution, is positive, and a positive complement fixation test can also be obtained. No specific cure has been discovered but amphotericin (see p. 184) is on trial.

Bacillary Dysentery

(Epidemic Dysentery)

Definition. A disease characterised by tenesmus, diarrhoea with the passage of blood and mucus, and caused by a special group of bacilli.

Etiology. There are three main types of bacilli: The *Shigella dysenteriae* (including the Shiga and Schmitz bacilli) which do not ferment manitol; the *Shigella sonnei* (Sonne bacillus); and the *Shigella flexneri* (including the Flexner and Boyd bacilli) which are manitol fermenting organisms. Flexner-Boyd and Sonne infections are generally of a milder type than are those caused by the *Shigella* group. Infection is carried to man by food and water, and transmitted from faeces by flies or by fingers. **Predisposing causes:** 1. **Locality:** Bacillary dysentery occurs in epidemics in the sub-tropics and also in temperate climates. Outbreaks of dysentery in England, including summer diarrhoea in children, are most often due to *Salmonella* infections, to staphylococci, to *Shigella sonnei* or to *Proteus morgani*. It affects armies, prisoners, and mentally diseased patients in institutions. 2. **Season:** In the tropics during the rainy season. 3. **Debility.** 4. **Age:** Infants under 2 years and adults of either sex.

Pathology. The bacilli produce an acute inflammation of the mucous membrane of the large intestine, and the last part of the ileum may also be affected. Small superficial pinkish ulcers and larger irregular transversely disposed ulcers form, and there is no undermining of their edges. Later the mucous membrane may necrose, becoming greenish-black. This may slough and leave a firm rigid tube of bowel.

Incubation Period. This varies from a few hours to about 7 days.

Clinical Findings. The patient is usually an adult, who is suddenly taken ill with abdominal pain and diarrhoea. There is malaise associated with fever and tenesmus may be very marked. In an acute case the patient has to go to stool very frequently, but little is passed each time. There may also be vomiting and considerable thirst.

Shiga infections. Blood culture is rarely positive ; there is usually a slight leucocytosis. In severe cases the blood urea rises and the alkali reserve falls.

Varieties. 1. Fulminating dysentery. This is usually a *Shigella* infection. It may be a choleraic type, with collapse, vomiting and diarrhoea, or a gangrenous type, with severe toxæmia and abdominal pain. 2. Mild type. In Great Britain the disease is not usually severe and commonly is due to the *Sh. sonnei*. Many persons excrete this organism without suffering from clinical dysentery. In children the onset is often abrupt, with abdominal pain, or lower abdominal discomfort, one or two loose green motions a day, without blood or mucus, and with little constitutional disturbance. 3. Chronic type. This persists for over a month, often with alternating constipation and diarrhoea. 4. Infantile or summer diarrhoea. Diarrhoea with blood and mucus in the stools may be due to a *Sonne* infection.

Differential Diagnosis. Bacillary dysentery differs clinically from amœbic dysentery in its more acute onset, higher temperature, greater degree of tenesmus, and more profound collapse. The stools differ in their appearance, those of amœbic dysentery usually being very offensive and containing faeces. They differ also in their cellular exudate. The causative organism is also distinct. Arthritis is a complication of bacillary dysentery, and liver abscess of amœbic dysentery. Other conditions which can be excluded clinically and bacteriologically are the enterica-group infections, food-poisoning, cholera and schistosomiasis. Ulcerative colitis is in some cases due to bacillary dysentery. Sigmoidoscopic examination is of value in the diagnosis of chronic dysentery. The mucous membrane is red, granular and bleeds easily, and the bowel wall is rigid.

Course and Complications. In fulminating *Shigella* cases the course is rapidly progressive to death ; in acute cases the diarrhoea usually lasts for 7 to 10 days, and the condition gradually improves as the motions become fœculant. Relapses may occur, the stools containing blood and mucus and a condition of chronic dysentery becomes established. Complications include arthritis, parotitis, conjunctivitis, iridocyclitis, ascites and constriction of the intestine. The arthritis usually affects large joints such as the knees ; there is clear fluid in the joint and recovery is the rule. It may occur during the acute stage or during convalescence.

Prognosis. The average mortality with early and adequate sulphonamide or antibiotic treatment is now between 0.05 and 2%. Fulminating cases die in a few days. *Shigella* infections are more severe than other types.

Treatment. *Prophylactic.* Endeavours should be made to prevent flies from having access to food ; faeces should be disposed of hygienically ; dysentery bacilli carriers should not be allowed to prepare food.

Curative. The patient must be kept warm in bed. Hot applications to the abdomen, such as turpentine stupes (see p. 588), help to relieve pain. If there is severe colicky pain an injection of morphin. hydrochlor. $\frac{1}{4}$ gr., (15 mg.) may be given for the first 2 days. *The Diet :* During the first 24 hours only water or mineral waters should be allowed.

Subsequently albumin water, dextrose water, thin arrowroot, Brand's essence and jelly are given. Sufficient fluid must be taken to produce a urinary output of about 2 pints (1.2 litre) in 24 hours. The diet is gradually increased by the addition of citrated milk, milk jelly, custard, sago pudding, a lightly boiled egg, toast or rusks, etc.

Special Treatment. Chlortetracycline (Aureomycin) may be given in doses of 2 G. followed every 12 hours by 1 G. for 4 doses. The drawback to these drugs is that they may lead to granular proctitis or to staphylococcal enteritis. Sulphonamide treatment proved of inestimable value in the treatment of bacillary dysentery but drug resistant strains have now appeared. Oral streptomycin is used for sulphonamide resistant organisms. It is best given combined with three sulphonamides as Streptotriad tab., 3 tabs. t.i.d. When the diarrhoea ceases the dose of the drug is tapered off, the total course not lasting longer than 14 days.

If there is severe dehydration 1,000 to 1,500 ml. of normal saline containing 5% dextrose should be given intravenously. Tenesmus can be relieved by a small starch and opium enema, Tnc. opii 20 m. (1.2 ml.), starch 60 gr. (4 G.), water 2 fl. oz. (60 ml.). If these measures fail a cœcostomy will give rest to the large intestine and also enable it to be washed out, and it is successful in some cases.

Spirochætal Jaundice

(*Spirochætosia Ictero-hæmorrhagica*. *Leptospiral Jaundice*. *Weil's Disease*)

Definition. A disease characterised typically by jaundice and hæmorrhages, due to a spirillum.

Etiology. Weil's disease is caused by the *Leptospira ictero-hæmorrhagica*, a coarse spirillum, whose dimensions are $12\mu \times 0.25\mu$. It is present in sewer rats (*Rattus norvegicus*), less commonly in the black rat (*Rattus rattus*) and is excreted in their urine, water thus becoming infected. The *L. canicola* is carried by dogs, and man may be infected. Transmission to man is probably through the skin, possibly by contaminated food, or by swallowing infected water while bathing in canals. **Predisposing causes:** **Locality:** Spirochætal jaundice occurs in Holland, Japan, Egypt, the Malay States, especially in mines, and was met with during the 1914-18 war in France and Gallipoli. Outbreaks have also occurred in Great Britain amongst sewer workers, tripe and fish cleaners, coal miners and farm workers.

Pathology. The body is usually jaundiced. Hæmorrhages may be seen in the muscles, skin, central nervous system, mucous membrane of the stomach and duodenum, and in the lungs and kidneys. The kidneys often show tubular degeneration. The liver may appear normal or fatty. The spleen is usually soft, and, in the type described by Weil, it is enlarged.

Incubation Period. This is usually 8 to 12 days.

Clinical Findings. The onset is usually sudden and there may be a rigor. The patient complains of headache and severe pains in the limbs and back. There may be marked giddiness and vomiting or diarrhoea. Milder cases also occur.

On Examination: The conjunctivæ are injected, the temperature is

high, about 103° F. (39.4° C.), and the pulse comparatively slow, 80 to 90. Jaundice appears in about half the cases, beginning on the third or fourth day, when the skin may itch. Petechial hæmorrhages may occur and bleeding from the gums or nose, and in some cases there is labial herpes which may be hæmorrhagic. Blood may be brought up from the stomach or lungs, or passed in the motions. The temperature remains irregularly raised and falls by lysis, reaching normal about the seventh to fourteenth day. It may subsequently rise again about the sixteenth day for a few days. The tongue is dry. The spleen is not usually palpable but the liver may be felt. The lymph nodes in the axillæ and groins may be enlarged. The motions are usually constipated and pale. The blood: The leptospira is present for the first week of the illness and may be demonstrated either by blood culture or by intraperitoneal injection of the blood or urine into the guinea-pig. A blood count shows a hæmolytic anæmia with a leucocytosis of 20,000 to 30,000 per c.mm. The platelet count is low. The serum after the sixth day will agglutinate formalised cultures of the leptospira in a dilution up to 1/30,000. An agglutination of 1/400 or over is considered to be positive and a rising titre indicates an active infection. The use of muscle biopsy has been recommended as an early diagnostic test, before the agglutination reaction becomes positive. As shown by Pick there is loss of striation, and vacuolation is seen in striated muscle fibres. The blood urea is often raised. The urine is scanty and contains protein, bile and blood, and the leptospira may be present after the tenth day. Jaundice rarely occurs in *L. canicola* infections, but meningitis or meningismus is not uncommon and often severe.

Differential Diagnosis. The disease must be differentiated from jaundice due to enterica infections and from yellow fever. Other conditions such as infectious hepatitis, and relapsing fever must be excluded. Cases without jaundice are liable to be mistaken for influenza. The diagnosis depends upon finding leptospira in the blood or urine, on a positive agglutination test, and the leucocytosis.

Course and Complications. Some cases pursue a severe course with intense jaundice and meningitis. Meningitis may occur apart from jaundice and the onset may be delayed for several months after the beginning of the disease. The diagnosis is established by finding the leptospira in the cerebrospinal fluid and urine by guinea-pig inoculation. Iritis may occur as a complication. Death may occur from hepatic toxæmia and uræmia.

Prognosis. The disease is a serious one, but the large majority of cases recover.

Treatment. Prophylactic. This is concerned with the destruction of rats and the wearing of shoes by miners in infected areas.

Curative. The patient should be put to bed, and the bowels opened with a saline aperient. The diet should be liquid, avoiding fats as for infectious hepatitis. Dextrose orangeade should be given and alkalis in doses sufficient to render the urine alkaline. Penicillin must be given in large doses, 1 million units (600 mg.) every 6 hours, to have any beneficial effect. Chlortetracycline (Aureomycin) may be tried in doses of 1 G. every 4 hours. Anti-Leptospiral serum, if available, may be given

in doses of 20 ml. intravenously three times a day for 8 days in a severe case. It should be given within the first 3 to 5 days, later it has little effect. The fæces and urine must be disinfected as for typhoid fever.

Canicola Fever

This is caused by infection with the *Leptospira canicola*, usually transmitted by dog's urine to man, less often by bathing when the source of infection is not known. Another source of infection is pigs. Ten cases occurred among workers in piggeries near Glasgow in the years 1957-63, and in some cases the organism was found in the kidneys of pigs. Water may be infected by the pigs' urine. Handling the infected organs may also cause the disease. Jaundice is a rare complication.

Tularæmia

(Rabbit Fever. Deer-fly Fever)

Definition. A disease characterised by fever and enlargement of lymph nodes, due to a specific bacillus.

Etiology. Tularæmia is caused by the *Pasteurella tularensis*. The disease occurs in squirrels, rabbits, water rats and sheep. It is conveyed to man by the deer-fly (*Chrysops discalis*). Man may also be infected in preparing dead rabbits for eating, and in laboratory work. Tularæmia is met with in Tulare County, California, in other parts of America, Japan, Russia, Norway, France, Belgium, Germany, Turkey, etc.

Pathology. Small areas of focal necrosis are found in various organs in the body.

Incubation Period. This is usually between 1 and 10 days.

Clinical Findings. The Glandular Type. A local papule appears at the site of the fly-bite. This ulcerates and the neighbouring lymph nodes enlarge. There is an irregular temperature, which may last for 2 or 3 weeks. The blood: A positive agglutination test may be obtained towards the end of the second week.

The Typhoid Type. When laboratory workers are infected the disease assumes the character of a septicæmia. There is irregular fever lasting for 2 or 3 weeks and relapses may occur for several months. The blood culture is usually positive.

Other types include the ophthalmic, pleuro-pulmonary, oral and abdominal.

Differential Diagnosis. The disease has to be distinguished from other septicæmias and from causes of lymph node enlargement with fever, such as the enterica group and plague. Injection into a guinea-pig of the fluid obtained by lymph node puncture is a method of isolating the bacillus. Other diagnostic measures include an intracutaneous, an agglutination, and a complement fixation test.

Course and Complications. The course is as described above. Bronchitis, bronchiopneumonia, pneumonia or pleural effusion may occur as complications.

Prognosis. The average mortality rate is about 5%, but it is higher in the pulmonary variety.

Treatment. The most effective treatment is streptomycin injected

intramuscularly in doses of 0.5 G. morning and evening for 12 days. In the pleuro-pulmonary variety the dosage should be 2 G. twice daily.

Cat Scratch Disease (*Cat-bite Fever*)

This resembles rat-bite fever. The causative organism has not been isolated. Two or three weeks after the bite or scratch of a cat the regional lymph nodes enlarge, there is a relapsing fever, and a macular rash appears on the forehead or trunk. Oval tender masses formed in the muscles in one of my cases. The disease is quickly cured by the intravenous injection of 0.3 G. neoarsphenamine or by injections of penicillin.

Rat-bite Fever (*Sodoku*)

Definition. A disease caused usually by the bite of a rat, infected with a special spirillum.

Etiology. Rat-bite fever is caused by the *Spirillum minus* (*Spirochaeta morsus muris*) or by the *Streptobacillus moniliformis*, as there are two different varieties with very similar clinical features. The organisms live in rats; man is infected by their bite or by the bite of an infected ferret. **Predisposing cause:** **Locality:** The disease occurs in Japan, in parts of India, such as Bombay, and sporadically in other parts of the world.

Pathology. The lymph nodes may be enlarged, and hæmorrhages seen in the lungs. The spleen is enlarged and the spirillum is found in the internal organs.

Incubation Period. This varies up to about 2 months.

Clinical Findings. The bite wound usually heals, but after a week or so breaks down with enlargement of the neighbouring lymph nodes. The patient now complains of headache, aching in the limbs, and there may be a rigor with nausea or vomiting.

On Examination: There are periodical rises of temperature up to about 102° F. (38.9° C.), lasting 2 to 5 days, followed by a crisis and an afebrile interval of 1 to 2 days. A purplish papular rash may be seen on the arms or trunk during the fever. Conjunctivitis and small painful swellings in the muscles have been noted. The relapses may continue for several months. The blood: The spirillum or streptobacillus may be found in the blood during pyrexial stages. There is usually a leucocytosis of about 15,000 per c.mm. with some eosinophilia and a positive agglutination reaction to the spirillum. The Wassermann reaction is positive.

Differential Diagnosis. The history of the bite and finding the organism in the blood differentiate rat-bite fever from such diseases as relapsing fever.

Course and Complications. The course is usually prolonged unless cut short by treatment. Nephritis may occur.

Prognosis. The disease is serious unless adequately treated.

Treatment. Benzylpenicillin should be injected intramuscularly in doses of 50,000 units (30 mg.) every 6 hours for 7 days for *Spirillum minus* infections, and for *Streptobacillus moniliformis* infection streptomycin is injected intramuscularly, 1 G. every 12 hours until the temperature has been normal for 2 days.

CHAPTER X

THE LOCOMOTOR SYSTEM

THE MUSCLES

Fibrositis

(Muscular Rheumatism. Myalgia)

Definition. Inflammation of the connective tissue of muscles, fasciae, ligaments, nerve sheaths, tendons and periosteum.

Etiology. This is uncertain. Exciting causes are strain, cold and damp climates.

Pathology. Small nodules are formed in some cases in the muscles and lipomatous masses occur between the superficial and deep fascia, which are vascular and become oedematous. These congested and swollen fatty masses tend to bulge through fibrous layers and to become strangulated. They are easily palpable.

Clinical Findings. The patient is usually an adult. There may be a history of cold, exposure, or commonly of muscular strain. The lumbar muscles are often affected (lumbago) or those of the neck (stiff neck) or chest (pleurodynia). An attack of lumbago may come on quite suddenly on stooping or on making a violent movement with the leg or arms, such as braking or cranking a car. In the subacute cases there is a less severe pain felt in the back, which is intensified on stooping, lifting, sneezing or coughing. On deep palpation the nodules, which are very tender, can usually be felt. A stiff neck (torticollis) usually follows sitting in a draught, one or other sternocleidomastoid or trapezius muscle being affected. The intercostal muscles may be involved, causing pleurodynia, which is usually unilateral.

Course and Complications. In lumbago the inflammatory process may extend to involve the sheath of the sciatic nerve, with consequent sciatica. Generally the patient recovers from an acute attack in 3 to 4 weeks, but he is liable to recurrences.

Treatment. During the acute stage rest and warmth are essential. In acute lumbago an injection of procaine 1% in normal saline into the tender nodules, or just beneath the surface of the fascia covering the affected muscles often gives rapid relief of pain and freedom of movement. Two to 10 ml. are injected at each site, up to a maximum of 80 ml. After the injection the patient is instructed to put the affected muscles through a full range of movement, and this should cause no pain. The patient should only remain in bed if the pain is very severe and cataplasma kaolini may be applied to the back every 12 hours during the acute stages. Aspirin 10 gr. (0.6 G.) t.i.d. or tab. codein co. 1 t.i.d., or tab. pethidine hydrochlor. 50 mg. by mouth may be given for the relief of pain. All strains to the back should be avoided and occupations involving stooping are most unsuitable.

Epidemic Myalgia

(Epidemic Pleurodynia. Bornholm Disease)

Etiology. This is a comparatively rare disease of epidemic nature, occurring chiefly in the summer months and affecting principally children and young adults. It was first described in Norway in 1872, and later in the Island of Bornholm in the Baltic, in 1930. In 1944 there was an outbreak in Alabama. Small outbreaks have been recorded in England. There is evidence that some epidemics are associated with infection by Coxsackie virus 1 or 2, or very closely allied viruses. Coxsackie is a village in New York State where the infection was first described in patients thought to be suffering from non-paralytic poliomyelitis, summer grippe or epidemic myalgia.

Clinical Findings. The incubation period is thought to be 2 to 4 days. The disease is characterised by a sudden onset of pain around the diaphragmatic attachments, often unilateral. The pain is intensified by coughing and sneezing. Pains may also occur in the abdomen, back, or neck, and frontal headache is a characteristic feature. The temperature is raised to about 104° F. (40° C.) for 24 to 48 hours. Dry pleurisy may be present. The disease must be differentiated from an acute abdominal lesion, especially when there are vomiting, abdominal distention, muscular rigidity and spasms of acute abdominal pain. It may also resemble influenza, but diaphragmatic pleurisy is not a characteristic feature of the latter. There is a tendency for a relapse to occur 2 or 3 days after the temperature has fallen to normal. In patients affected with the Coxsackie virus complement-fixing antibodies are found in the serum by the third day, and they show a rising titre. The virus has also been recovered from the throat and faeces of patients suffering from the disease.

Treatment. This consists in rest in bed, a bandage round the lower ribs to diminish diaphragmatic movement, and aspirin for relief of pain.

Primary Myositis Fibrosa

Etiology. This is unknown.

Pathology. The muscle fibres atrophy, and are replaced by connective tissue.

Clinical Findings. The patient notices swelling and pain in the muscles of the legs.

On Examination: There is little tenderness, but the affected muscles are very hard, and subcutaneous oedema may be found over them.

Prognosis. The disease often spreads until nearly all the voluntary muscles are affected.

Treatment. Massage and electrical treatment may be tried, and improvement often results.

Polymyositis

A condition of muscular weakness affecting especially the shoulder-girdle and pelvic-girdle muscles, and the proximal rather than the distal

limb muscles. The chief other symptoms are fatigue, muscular stiffness and loss of weight. Females predominate in the ratio of 2 to 1. The patient is usually in the sixth decade, but the disease may show itself at any age.

In the primary cases no cause is found. The secondary cases may be associated with bronchial carcinoma, sarcoidosis, Cushing's syndrome and disseminated lupus erythematosus.

The serum aldolase level is raised to over 10 Bruns units per ml., often to 60 units, and creatine is present in the urine in many cases. The sedimentation rate of the red cells is increased in about 50% of cases, and the serum glutamic oxalacetic transaminase (SGO-T) may also be elevated. Muscle biopsy may be normal and electromyography shows changes in about half the cases.

Treatment. In the primary variety prednisone should be given in large doses, first 60 mg. daily until improvement is noted, despite side effects. The dose is then gradually reduced, a small daily dose being usually required.

Polymyalgia Rheumatica

(Anarthritic rheumatism)

Pain is felt in various muscles, with malaise and at times fever. The sedimentation rate of the red cells is always raised. There is muscular weakness but no joint involvement. The serum enzymes, aldolase and creatine-kinase, are normal. Biopsy of the temporal and other arteries may show giant-celled arteritis or non-specific arteritis. By some it is regarded as a form of arthritis affecting the spine and limb girdles, by others as a variant of rheumatoid disease. Electromyography may show abnormal foci in the muscles. The disease affects chiefly elderly people.

Treatment. Prednisone should be given, 5 mg. tab., one q.i.d. for 2 weeks, then one t.i.d. for 2 weeks, then one b.i.d. for several months.

Progressive Myositis Ossificans

Etiology. The cause is unknown.

Pathology. Embryonic connective tissue is first formed; this is converted into fibrous tissue, and later ossification occurs. Deposits of bone are found in the muscles, tendons, ligaments and fasciæ, and there are exostoses. Some cases follow trauma and are preceded by a hæmatoma.

Clinical Findings. The patient is usually a young adult; men are attacked more frequently than women. The early symptoms suggest muscular rheumatism, and at the onset there may be slight fever with redness or swelling of the skin over the affected muscles, usually the back and the neck. Bone formation gradually occurs in the muscles and spreads to the ligaments, causing fixation of joints. The muscles of mastication may be involved, with fixation of the jaw. Severe scoliosis may ensue. Exostoses are frequently noted on the humerus, tibia, fibula and ribs. The big toes and thumbs are deformed and small,

the interphalangeal joint being ankylosed and the metacarpal or metatarsal bone stunted.

Prognosis. This is very unfavourable, and death usually occurs from some intercurrent infection after the patient has become bedridden.

Treatment. There is no curative treatment; good nursing care is required in advanced cases.

Other affections of voluntary muscles which are mentioned under their particular sections include: Trichiniasis (see p. 771). Degenerations (such as Zencker's degeneration: see typhoid fever, p. 584). Hæmorrhage, as in scurvy or in influenza (see p. 602), into the rectus abdominalis. Rupture, as in tetanus. Tuberculosis: A cold abscess in muscle may be due to direct spread from a bone abscess; rarely in miliary tuberculosis foci are found in the voluntary muscles. In syphilis a gumma may form. Cases of acute streptococcal myositis of unknown origin have also been recorded.

The Muscular Dystrophies

(The myopathies and muscular diseases of doubtful nature)

In this group of cases the primary changes are regarded as muscular rather than nervous. The characteristic features of the myopathies are:—A familial history. The age of onset. Different muscle groups are affected in different types. Pseudo-hypertrophy occurs in some cases. There are no fibrillary contractions such as occur in spinal medulla (cord) lesions. There is no reaction of degeneration and no sensory changes occur, as in neuritis.

Pseudo-hypertrophic Muscular Dystrophy

(Duchenne type)

Etiology. The cause is unknown. The disease tends to run in families, being transmitted by the mother. Female carriers of the gene may have hypertrophy of the calves and elevation of the serum creatine kinase. The sex-limited recessive form appears only in boys. In the autosomal recessive variety girls are occasionally affected.

Pathology. There is atrophy of the muscle fibres, with increase in the fat and connective tissue of the affected voluntary muscles, causing apparent enlargement. There are no changes in the central nervous system.

Clinical Findings. The patient is usually a boy, aged 3 to 12 years. There is a history that he began to walk late, and that he has been unsteady on his legs and finds stairs difficult.

On Examination: The general condition is good and there is enlargement of the muscles of the calves (gastrocnemius and soleus), the front of the thighs (quadriceps femoris and sartorius), the buttocks (glutei), the infrapinnatus, triceps and at times the deltoid. The enlarged muscles are found to be weak. The patient stands on a wide base, lordosis is marked, the gait is waddling, and in order to rise from a supine posture the patient "climbs up himself," first rolling over on

to his hands and knees, and then working his hands up his legs. There is usually wasting of the latissimus dorsi and lower part of the pectoralis major muscles, so that if the child is lifted up under the arms he tends to slip through the hands. The face, with the exception of the masseter muscles, and the forearms are not affected. There are no sensory changes. The deep reflexes in connection with the affected muscle groups are gradually diminished and there are no fibrillary tremors. The serum creatine kinase activity is raised above the normal of 2 units/ml. Electrical reaction: The reaction of degeneration is not present, but the response to faradisation and galvanism gradually diminishes. The electromyogram may show characteristic changes.

Course and Complications. The disease is progressive, but there may be apparent improvement between the age of 5 and 8, and death usually occurs before adult age from wasting or secondary infections.

Treatment. There is no curative treatment and it is doubtful whether nucleotides and nucleosides in the form of Lævadosin are of value. Massage and exercises are usually beneficial.

Juvenile Muscular Dystrophy

(*Erb's Dystrophy*)

Etiology. The cause is unknown.

Pathology. There is wasting of the fibres of the affected muscles.

Clinical Findings. The patient is usually between the ages of 15 and 35, male or female, and several members of a family may be affected. It is usually inherited by an autosomal recessive mechanism. Weakness is first noticed in the arms or legs and the muscles are later found to be wasted.

On Examination: The muscles wasted are usually those of the limb girdles, the upper arm (biceps, triceps and brachioradialis) and the thigh (glutei, extensors and hamstrings), giving a bottle-shaped appearance to the limbs. Some of the trunk muscles may also waste, such as the latissimus dorsi, lower part of the pectoralis major, trapezius, rhomboids, serratus anterior, erector spinæ, etc. The face is not usually affected. Lordosis is present, the electrical reactions and deep reflexes are diminished. The reaction of degeneration is not present and there are no sensory changes and no fibrillary tremors. In some instances a distal type (of Gowers and Spiller) may be seen, in which the forearms, hands and wrists, legs, feet and ankles, and muscles of the face are wasted.

Course and Complications. The disease is usually progressive, but the patient may live until middle age before being carried off by some intercurrent infection.

Clinical Findings. Weakness and wasting are first noticed in certain face muscles. These are the orbicularis oris and orbicularis oculi; the eyelids cannot be closed and the lips are everted; the lower lip projects (tapir mouth). On smiling the lips are straight. The shoulder girdle muscles, including the trapezius, latissimus dorsi, serratus anterior, pectorals, triceps and biceps, are subsequently affected. The scapulæ become winged.

Course and Complications. The course is progressive, but the patient may live until adult life.

Amyotonia Congenita or Myatonia Congenita

(Oppenheim's Disease)

Etiology. This is unknown. The disease resembles a myopathy in many respects.

Pathology. The anterior horn cells of the spinal medulla (cord) are usually diminished in number, especially in the lumbar region, and the corresponding ventral nerve roots are thin and deficient in myelin. The muscle fibres on the whole are small, but a few abnormally large ones are found. The connective tissue and fat of the muscle are increased.

Clinical Findings. The disease may have a familial incidence. The onset is at, or before birth, and the condition is characterised by extreme flaccidity of the voluntary muscles; an infant, if sitting, tends to fall forwards and resembles a frog (Batten's frog child). The muscles are very weak and the child may be unable to hold up its head. The legs are more severely affected than the arms. The hands and feet are long and narrow. The face is not affected. The deep reflexes are absent, and the electrical response to faradisation is diminished, but the reaction of degeneration is not present.

Differential Diagnosis. Amyotonia congenita is differentiated from poliomyelitis by the general distribution of the paresis and absence of complete paralysis in amyotonia congenita, and from the myopathies by the absence of marked wasting and the tendency to improvement. Its resemblance to the Werdnig-Hoffmann disease has been noted on p. 447.

Course and Complications. The child may soon die from inter-current infection, but there is a tendency to improvement with an increase of muscle tone and recovery of the deep reflexes, so that he may survive and reach adult life.

Myotonia Congenita

(Thomsen's Disease)

Etiology. The cause is unknown.

Pathology. The voluntary muscle fibres may be increased in width. There is no increase in the muscular connective tissue and there are no nervous changes. The muscular contractions resemble

those produced experimentally with veratrin, there being delay in contraction and relaxation.

Clinical Findings. The disease is very rare, occurring more commonly in males, tending to run in families, and first showing itself in childhood. The patient notices a stiffness in the voluntary muscles, chiefly in the hands, arms, feet and legs, and to a lesser degree in the trunk. The muscles of mastication may also be affected.

On Examination: It is found that the voluntary contraction and relaxation of the muscles is prolonged, but a movement becomes more speedy after repetition. This can be well tested by asking the patient to grip the hand several times. There is no spasticity found on passive movement. The skeletal muscles are usually enlarged. The sensation is normal. The following distinctions exist between this condition and the myopathies: The deep reflexes are not affected; there is no atrophy of muscles; the electrical reaction is peculiar, the faradic and galvanic responses are first small and prolonged, but on repeated stimulation they become normal (myotonic reaction); there is a modified reaction of degeneration, as A.C.C. approximates to K.C.C. (normally $K.C.C. > A.C.C.$ and in the reaction of degeneration $A.C.C. > K.C.C.$).

Course and Complications. The disease has no effect on the duration of life.

Treatment. Procaine amide hydrochloride (Pronestyl) should be given by mouth, 0.25 G. tab., 1 tab. q.i.d. up to 4 G. a day.

Myotonia Atrophica (*Dystrophia Myotonica*)

Etiology. The cause is unknown.

Pathology. There is atrophy of the majority of fibres in the affected muscles, with some giant fibres.

Clinical Findings. The patient is usually a male, aged between 20 and 35. There is often a family history of the disease and also of cataract. The onset is insidious, with pains in the arms or legs, weakness, loss of weight and a difficulty in relaxing the grip.

On Examination: There is wasting of the muscles of the face, the neck (sternocleidomastoids), the forearms and the legs, and the testicles may be atrophied. The deep reflexes in connection with the affected muscle groups are diminished. There are no sensory changes, no fibrillary contractions and no reaction of degeneration. Electrical stimulation causes a prolonged relaxation after contraction.

Course and Complications. The course, if untreated, is slowly progressive. Death usually occurs from intercurrent disease.

Treatment. Procaine amide hydrochloride may be given as in myotonia congenita.

Ocular Myopathy

This was formerly described as progressive nuclear ophthalmoplegia. There is bilateral ptosis and external ophthalmoplegia. Weakness may

spread to the lower facial muscles, and to the neck, trunk and arm muscles. There is dysphagia in about half the cases.

Myasthenia Gravis

Etiology. The cause is unknown. The disease appears to be due to a chemical abnormality (deficiency of acetyl-choline) which results in a defect of transmission of the impulse from the nerve to the muscle. Acetyl-choline is the chemical substance which allows transmission of impulses across the myo-neural junctions in striated muscles, but acetyl-choline itself has no beneficial effect in the disease. It is thought that eserine and neostigmine (Prostigmin) inhibit the destruction of acetyl-choline by an esterase. It has been suggested that it is an auto-immune disease, the thymus producing an antibody against muscle end-plate protein.

Pathology. "Lymphorrhages" (small round cells) are found between the muscle fibres. There are no primary changes in the nervous system. The thymus is frequently enlarged containing many lymphoid germinal centres and a thymoma may be present.

Clinical Findings. The disease affects women twice as frequently as men, and usually begins in adults before middle age, but it may be met with in young children. The patient may complain of inability to keep his eyes open or of diplopia, which increases during the day and disappears temporarily after a night's rest. In other cases varying fatigue is noticed in different muscles causing difficulty in speech or swallowing, alteration in voice, or weakness of the neck or limbs. Thus, if the arm is affected, the performance of any movement involving its use will cause rapid fatigue, power being regained temporarily after a short rest. Aching in the limbs may also be noticed.

On Examination; In a typical case certain muscles supplied by the cranial nerves are affected, especially those of the eyelids and the external oculo-motor muscles, with resulting ptosis, strabismus and inability to close the eyes tightly. Monocular myasthenia gravis has been described. The lips may also be involved so that the patient cannot whistle or smile normally. If the palate is affected it rapidly fatigues when the patient is asked to say "Ah." The voice may be nasal and nasal regurgitation of fluids occurs on swallowing. The tongue and jaw muscles may also be involved, with dysarthria and dropping of the jaw. In other cases there is weakness of the neck so that the head is supported on the hands, or fatigability of the arms may be demonstrated, for when the patient holds the arms extended they gradually droop to the sides. The muscles are not usually wasted, the deep reflexes are variable; the jaw-jerk may be abolished, but the knee-jerk is not lost. The electrical tests show the "myasthenic reaction"; the response to faradisation is rapidly exhausted, but is restored by rest. Galvanic stimulation does not fatigue the muscles and they will contract voluntarily when they do not respond to faradisation. Sensation is usually unaffected. The urine: The creatine content is high, and creatinine low.

Differential Diagnosis. The characteristic expression of the patient with drooping eyelids and elevated head, and the fatigability of the muscles are typical. Other causes of ptosis must be excluded, such as hysteria, tabes dorsalis and cerebral lesions. Organic bulbar paralysis and diphtheritic neuritis must be differentiated in some cases.

Course and Complications. The course is progressive, but may be interrupted by remissions, especially during pregnancy. Involvement of the respiratory muscles may cause death.

Treatment. Electrical treatment should not be given. If neostigmine methylsulphate 1 to 2.5 mg. and atropin. sulph. 1/100 gr. (0.6 mg.) are injected subcutaneously the patient recovers power in the affected muscles in about 10 minutes, and the effects are maintained for about 3 to 6 hours. To produce comparable results by oral administration, 15 mg. of neostigmine bromide are equivalent to an injection of 1 mg. A severe case may require as many as twenty 15 mg. tablets of neostigmine bromide spaced out through the 24 hours. In each case the maintenance dose must be worked out. To prevent abdominal pains, tnc. belladon. 20 m. (1.2 ml.) should be taken as required. Pyridostigmine bromide (Mestinon) is less liable to produce side effects, a 60 mg. tab. being equivalent to 15 mg. neostigmine. Thymectomy has been successful in many instances especially in young women with severe disease of short duration. Good results have also been obtained in some cases by radio-therapy, when the thymoma has been demonstrated by lateral tomography, followed by thymectomy.

Familial Periodic Paralysis

(*Intermittent Myoplegia*)

Etiology. The cause is unknown. The disease tends to run in families. It is a disorder of electrolyte metabolism, inherited as an autosomal dominant character.

Pathogenesis. It is thought that potassium enters the muscle cells during the attacks. It has been shown that an attack can be produced in a susceptible individual by the administration of dextrose, 200 G., by mouth. This results in the fall of the blood potassium, paralysis usually appearing when the figure is below 10 to 12 mg. per 100 ml. (normal 17 to 22 mg. per 100 ml.), 2.6 to 3.1 mEq./L. (normal 4.4 to 5.6 mEq./L.).

Clinical Findings. The disease usually first shows itself in childhood or about the age of puberty. There are recurring attacks of paralysis which may affect the arms, legs, trunk and neck. Usually the face, eyes, sphincters and diaphragm are not involved. In some cases only the lower limbs are affected and the weakness may be greater in one half of the body than the other. Premonitory symptoms are sometimes noted, such as lassitude, tingling in a limb, hunger, thirst, palpitations or sweating. A heavy meal may predispose to an attack. The onset usually occurs during sleep, the patient on waking finds that he cannot move his limbs. The attack usually passes off in a few hours or in a day or so.

On Examination : The affected muscles are flaccid and completely or partially paralysed. The cutaneous and deep reflexes are diminished or abolished. The electrical reactions are diminished or absent. Sensation is usually normal. The blood potassium falls during an attack to less than 3 mEq./L. (12 mg. per 100 ml.).

Differential Diagnosis. Owing to the rarity of the condition and the transitory nature of the attacks, the patient runs a risk of being diagnosed as suffering from hysteria or malingering. The condition must also be differentiated from *potassium-losing nephritis*, which may be met with in patients suffering from chronic pyelonephritis. This usually first shows itself in a later age group than does familial periodic paralysis. In potassium-losing nephritis the attacks are of longer duration and usually more severe, hypopotassaemia and muscular weakness tend to persist between the attacks. In the absence of proteinuria tests of tubular function, such as the urine concentration test and the ability to acidify the urine, will usually show evidence of renal failure. *Hyperkalaemic periodic paralysis* may also occur, usually directly after exercise. *Thyrotoxic periodic paralysis* is associated with hypokalaemia. It occurs especially in males.

Prognosis. The attacks tend to become less severe and frequent after middle age.

Treatment. The patient should avoid a high carbohydrate diet, which lowers the serum potassium. The attack can usually be relieved by administering at the onset pot. chlorid. 90 to 180 gr. (6 to 12 G.) for an adult, and 15 to 30 gr. (1 to 2 G.) for an infant, dissolved in 2 fl. oz. (60 ml.) of water and taken in a small quantity of milk.

The Stiff-Man Syndrome

This disease was first described at the Mayo Clinic in 1956. It is characterised by progressive, fluctuating, muscular rigidity and spasm. There are also attacks of extremely painful muscular spasm, resembling those of tetanus. The affected muscles appear normal during sleep, but when the patient is awake the affected muscles are hard and contracted, between the attacks. Injections of morphine do not afford relief. Asher, later, described a case in a woman.

THE BONES

Osteitis Deformans

(Paget's Disease)

Definition. A chronic disease of bone, characterised by enlargement of the skull, kyphosis and bowing of the extremities.

Etiology. The cause is unknown. The disease is almost always associated with atheroma.

Pathology. The pelvis, spine, skull, tibia, or clavicle is generally first affected. The changes are those of subperiosteal new bone formation and deeper areas of rarefaction. There is much bony thickening and irregularity. The skull is thickened with narrowing of the foramina and



FIG. 61. SKULL IN PAGET'S DISEASE.



FIG. 62. PAGET'S DISEASE SHOWING LEFT FACIAL PALSY.

sutures (see Fig. 61). The bone fat is increased and its calcium diminished. The rate of blood flow through the bones may be very considerably increased.

Clinical Findings. The patient is usually a male, aged 40 to 60, and the disease tends to run in families. The onset is insidious; pains may be first noticed in the legs (shins), or enlargement of the head or bending of the bones may be the first symptom. *Examination of a Developed Case:* The patient presents a typical appearance; the calvaria is enlarged, and the face appears triangular with the base upward (see Fig. 62). The legs and arms are bowed forwards and outwards. Kyphosis is marked, usually in the upper thoracic region, and the spine is very rigid. There is also thickening and enlargement of the pelvis, shoulder girdle, tibiae and femurs, and to a lesser degree of the bones in the arms. The patient's height may be reduced by 4 to 6 inches (10 to 15 cm.), but the hands and feet are usually unaffected. In rare cases the changes are limited to a single bone such as the clavicle, the ischium, pubis, ilium or one vertebra. The disease is then said to be monostotic, and is discovered accidentally on X-ray examination. In these cases the alkaline serum phosphatase may not be increased. In the majority of cases extensive arteriosclerosis is noted. The skin over the affected bones may be red and hot. Narrowing of the foramina in the skull may compress the cranial nerves, and give rise to optic atrophy, oculo-motor paresis, deafness and perhaps facial palsy (see Fig. 62). X-ray examination of the bones shows the enlargement and deformity, and areas of rarefied spongy bone and of dense amorphous bone are seen, giving a woolly appearance to the skull. The blood: The serum calcium and phosphorus are normal. The alkaline phosphatase is usually increased. The sedimentation rate of the red cells is likely to be normal. The urine calcium content is usually increased in the early stages, later it may be normal or diminished. It has been shown that if the affected bone is immobilised, bone destruction continues without bone formation. There is then an excess of calcium in the blood and increased calcium excretion in the urine. If the kidneys fail to excrete the calcium, death may occur from hypercalcaemia. A similar effect may be produced by keeping the patient in bed.

Differential Diagnosis. There is usually no difficulty in distinguishing Paget's disease from acromegaly, rickets and localised overgrowth of bone due to other causes, such as trauma or syphilis. The X-ray findings are characteristic. Secondary carcinoma of bone may give rise to difficulty, but the primary growth can usually be found, and the X-ray appearances differ. The sedimentation rate of the red cells is increased in carcinoma.

Course and Complications. The course is progressive; the patient may live for 20 to 30 years after the onset, gradually becoming more crippled, and dying from an intercurrent disease. Congestive heart failure may result from increased blood flow through the affected bones, the circulatory disturbance being analogous to an arteriovenous shunt. Fracture of the long bones, compression paraplegia, or osteosarcoma may occur.

Treatment. There is no specific treatment. Osteotomy is not usually advisable but division of the periosteum may relieve pain. Analgesic drugs, such as aspirin, may be required for the pain. In the early stages the diet should be rich in calcium and phosphorus, and vitamin D 10,000 units and vitamin C 1,000 units (50 mg.) taken daily. X-ray treatment may relieve the pain for 2 to 8 months. A low calcium diet with plenty of fluid by mouth or intravenously should be given if the patient is confined to bed and the blood calcium is excessively high.

Focal Osteitis Fibrosa

(Osteitis Fibrosa Circumscripta)

This is a condition resembling generalised osteitis fibrosa (see p. 706), but affecting only one or a few bones, with a definite tendency to spontaneous arrest. The bone lesions are frequently unilateral. It occurs chiefly in adolescents, and there may be spontaneous fracture. The blood calcium and plasma alkaline phosphatase are normal and the disease is not associated with a parathyroid tumour or with hyperparathyroidism.

Leontiasis Ossea

A condition of hyperostosis of all the bones of the skull, including the face bones. The cause is not known, but in some cases it may be associated with chronic sinusitis. It occurs usually about the age of puberty and is more common in women than in men. The patient complains of pressure effects, such as headache, neuralgia, deafness, blindness and insomnia. Death may not occur for 30 to 40 years and may be due to intercurrent diseases or to a convulsion.

Osteoporosis

Osteoporosis is an extremely common disease. The bone matrix is composed of nitrogenous substances. In osteoporosis there is a disorder of protein metabolism resulting in a deficiency in the rate of formation of bone matrix. This may be due to a reduction in activity of osteoblasts.

Several varieties are described : 1. *Disuse*. Absence of movement removes the stresses and strains which stimulate osteoblastic activity. 2. *Post-menopausal*. Due to lack of oestrogens. 3. *Senile*. Due to lack of androgens or oestrogens, or both. 4. *Nutritional deficiencies and glandular disturbances*. Insufficient protein intake may cause a deficiency of nitrogenous supplies to the bones. Osteoporosis may also be due to lack of vitamin C, hyperthyroidism, diabetes mellitus, Cushing's disease, or to the administration of ACTH or of corticosteroids. 5. *Congenital*. Fragilitas ossium is a disease of unknown etiology. 6. *Idiopathic*. Osteoporosis may follow a comparatively trivial accident or a normal pregnancy. 7. *Localised*. Osteoporosis may occur in such conditions as Sudeck's atrophy of the bones of the hands.

From the clinical standpoint the senile and post-menopausal varieties are most important. They cause spinal osteoporosis. The spine, the pelvis, and the neck of the femur are specially affected. The

centre of the vertebra becomes bi-convex, the "cod-fish" vertebra. The body of a vertebra may collapse, and fracture of the neck of the femur may occur. The serum calcium, phosphorus and alkaline phosphatase readings are normal. The patient loses height, sometimes as much as 4 or 6 inches (10 or 15 cm.), and a transverse crease forms across the upper abdomen. Transparent skin on the back of the hands occurs especially in women over the age of 60.

Treatment. After the age of 60 years regular yearly records should be kept of an individual's height. In this way spinal osteoporosis will be recognised in an early stage. The diet should be rich in protein and, when the disease is present, male and female sex hormones should be administered by mouth, methyltestosterone 10 mg. and dienestrol 1 mg. daily. These should be given for 4 weeks, omitted for 2 weeks, and then repeated again for 4 weeks, and so on. A pint (600 ml.) of milk a day should be drunk, which contains 680 mg. of calcium. Overdosage with calcium or vitamin D is not required, and may be harmful.

Osteomalacia

Definition. A deficiency disease characterised by softening of bones with a liability to fracture.

Etiology. Osteomalacia may be due to several causes: 1. Deficiency of calcium and vitamin D in the diet and absence of sunlight: The blood calcium is low and there is a negative calcium balance. It appears to be an adult variety of rickets. This is the cause in the majority of cases. 2. Deficient absorption of calcium and vitamin D in idiopathic steatorrhœa. 3. Increased excretion of calcium in the urine, as in the Fanconi syndrome (see p. 689). 4. Following removal of a parathyroid tumour in generalised osteitis fibrosa. 5. Milkman's syndrome. This is by some considered to be a variety of osteomalacia. 6. Gastric resection. Osteomalacia is endemic in Northern India, Japan and Northern China. Males are occasionally affected.

Pathology. The bones are brittle, owing to lack of calcium. The bones especially affected are those of the pelvis, spine, thorax and the long bones.

Clinical Findings. The patient is usually a woman between the ages of 20 and 30, who complains of weakness and aching in the back, chest or legs. Deformity is usually produced, especially in the pelvis, which interferes with childbirth; there may also be kyphoscoliosis, chest deformities, coxa vara and bending of the long bones. A spontaneous fracture of a long bone may occur. The X-rays show that the bones are rarefied. In severe cases the bone markings disappear and the bones may not cast a more dense shadow than the surrounding tissues. The plasma phosphorus and, at times, the serum calcium figures are below normal. The clinical findings in idiopathic steatorrhœa have been described on p. 61.

Milkman's syndrome may or may not be a variety of osteomalacia. X-ray examination shows incomplete pseudofractures involving the flat and tubular bones. They often occur at the site of pressure of an artery, as where the circumflex scapular artery winds round the axillary border

of the scapula. Paired bones are often symmetrically involved. There is no bending or bowing of the bones as is liable to occur in late rickets or osteomalacia. The softening begins in the cortex and entirely encircles a tubular bone, extending into the marrow cavity. There is no attempt at repair. The blood chemistry is normal. The patient has often a waddling gait and complains of pain in the affected bones.

Differential Diagnosis. Osteomalacia is characterised by the bony changes in the pelvis, and is to be differentiated from osteogenesis imperfecta, generalised osteitis fibrosa and osteitis deformans.

Course and Complications. Tetany may occur as a complication.

Prognosis. A complete cure can usually be effected with adequate treatment.

Treatment. The patient should be treated as for rickets with cod-liver oil, Haliverol or calciferol, sunlight and a diet rich in calcium and phosphorus, such as milk, eggs, fish and green vegetables. In Milkman's syndrome, and in vitamin D resistant cases of osteomalacia, calciferol should be injected intramuscularly in doses of 600,000 units 3 times a week. Calcium lactate should be given by mouth in doses of 60 gr. (4 G.) t.i.d.

Multiple Myelomatosis (Kahler's Disease)

This disease is characterised by the formation of reddish tumours in the bone marrow, anæmia, and Bence Jones protein in the urine. Spontaneous fractures may occur. The tumours are composed of hæmopoietic cells. A variety localised to one bone is known as a plasmocytoma. The patient complains of aches or pains in the pelvis or chest, and there may be paraplegia. The blood shows a leucocerythroblastic anæmia, *i.e.*, a hypochromic anæmia with normoblasts. The total number of leucocytes is not increased, but a few myelocytes and myeloblasts are present. The serum globulin is usually increased, and the sedimentation rate of the red cells is rapid. Amyloidosis occurs in about 15% of cases. The differential diagnosis includes Paget's disease, Ewing's sarcoma, secondary malignant deposits in bone and syphilis of the bones. The X-ray appearances of the bones, the blood count, the presence of Bence Jones protein in the urine and the result of sternal puncture which shows plasma cells in the bone marrow, serve to establish the diagnosis. The prognosis is hopeless, but X-ray treatment to the bones may relieve the pains. Urethane has been recommended as relieving pain and improving the general condition. It may be prescribed as Urethane 15 gr. (1 G.), syrup. aurant. 20 m. (1.2 ml.), aq. chlorof. ad 1 fl. oz. (80 ml.). The usual dose is 4 to 6 G. daily for 3 weeks, and then 2 G. for a week or so. It is discontinued if there is leucopenia. An aromatic nitrogen mustard, Alkeran or Melphalan, may relieve pain and increase mobility in doses of 1 mg./kg. body weight (2 mg. tab.). It is a bone marrow depressant, and may be given for 7 days at intervals of 4 to 8 weeks. Prednisone, 40 mg. a day, in divided doses for 7 to 10 days, may relieve the pain.

Diffuse Osteosclerosis

(Albers-Schönberg Disease. Marble-bone Disease)

The bones become unduly rigid owing to thickening with loss of the marrow cavity. The ossification probably starts before birth and fractures are not uncommon. X-ray examination shows a homogeneous density of bone, due to deposition of calcium in the medulla. The marble bone is soft and can be cut with a knife. The upper and lower edges of the vertebral bodies may be affected giving a characteristic appearance (see Fig. 63). The liver and spleen are enlarged. The blood may show a leuco-erythroblastic anaemia.

Osteogenesis Imperfecta

(Fragilitas Ossium)

A congenital disease characterised by extreme brittleness of the bones, multiple fractures occurring before or after birth. It is sometimes associated with otosclerosis and blue sclerotics. There are often protuberances on the skull and the limbs are short. The cause is unknown. The serum calcium, plasma phosphate and calcium excretion are usually normal.

Osteopsathyrosis

(Lobstein's Disease)

This closely resembles osteogenesis imperfecta, but the fragility of the bones is not noticed until childhood or later. It often runs in families.

Achondroplasia

A congenital disease, characterised by arrested development of the bones of the extremities, with consequent dwarfism. The head is large, the bridge of the nose depressed, and the hands are small with fingers of equal length. Lordosis is present with contraction of the pelvis. The skin over the body is thick, the voluntary muscles are powerful and the mentality is normal. Males and females are equally affected.

Oxycephaly

(Craniofacial Stenosis)

This rare congenital disease is characterised by deformity of the skull, the vertex being pointed and forehead sloping, together with the occurrence of exophthalmos and optic atrophy. It is considered to be due to premature union of the sagittal and coronal sutures. "Digital impressions" formed by bony trabeculae are seen post-mortem on the inner aspect of the vault of the skull, which during life give a beaten silver appearance on X-ray examination. The patient complains of headaches, failing vision and possibly loss of smell. Decompression, or King's mosaic operation, in which the vault of the skull is separated into small squares, may be required to relieve the pressure.

Hypertrophic Osteoarthropathy

A condition of "clubbing" of the fingers (Hippocratic fingers) or toes often associated with enlargement of the wrists or ankles.

Etiology. The cause is not known; impeded venous return, œdema and toxæmia may be factors. It is usually found associated with chronic diseases of the lungs and pleura, such as fibroid tuberculosis, bronchiectasis and empyema, with mediastinal tumours and congenital disease of the heart. In some instances no cause can be found. It may develop in a few weeks in such conditions as an empyema. Unilateral clubbing may occur.

Pathology. Clinically there are two varieties, the drum stick, with bulbous extremities to the fingers, associated with bronchiectasis, and the parrot-bill or puffin-beak variety, in which the nails are curved from base to tip. This is met with in tuberculosis. In the early stage the first sign is congestion of the finger tips, at the roots of the nails. In more advanced cases there is enlargement of the hands and feet and swelling of the wrists and ankles; and an intermittent hydrarthrosis may occur in other joints such as the knee. The changes are chiefly in the soft tissues, and by X-rays subperiosteal thickening may be seen.

THE JOINTS

Osteoarthritis

(*Hypertrophic Arthritis. Degenerative Arthritis*)

Definition. Degenerative joint lesions of doubtful etiology.

Etiology. Trauma and strain are exciting factors in some cases.

Predisposing causes: 1. Age: Usually over 40. 2. Sex: Males predominate. 3. Metabolic errors: The nature of these is uncertain.

4. Obesity.

Pathology. The joints most commonly affected are the terminal interphalangeal joints where Heberden's nodes occur, the lumbar vertebræ, the knees, the sacro-iliac joints, the lower cervical vertebræ, the hips and shoulders. There is degeneration of the articular cartilage, with hypertrophy of the surrounding cartilage and bone, so that the articular surfaces are approximated. The synoviae are usually unaffected. Separated osteophytes may be loose in the joints. The joint capsule is fibrosed. Osteoarthritic changes are present in nearly everyone after the age of 50, but symptoms only occur in a small percentage of individuals.

Clinical Findings. The onset is usually insidious, with stiffness and later pain in the affected joints. There is no constitutional disturbance except in the rare acute type of disease. When the hip is affected the pain may be referred to the front or back of the leg (femoral or sciatic neuralgia) or to the knee.

On Examination: The general nutrition is good. The affected joint shows some bony thickening, and lipping of the bony edges may be felt.



FIG. 63. THE SPINE IN MARBLE-BONE DISEASE.

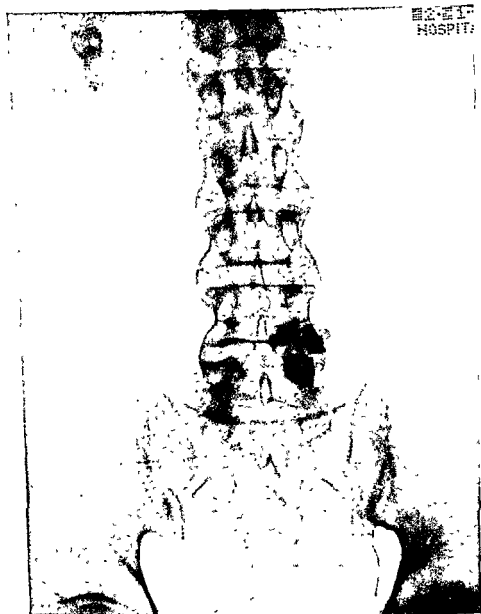


FIG. 61. THE BAMBOO SPINE IN ANKYLOSING SPONDYLITIS.

Creaking is often audible and palpable on movement, and the range of movement is limited. Some muscular wasting may occur above or below the joint, and in cases in which the hip joint is affected the patient may walk on his toes with tilting of the pelvis and scoliosis. Most patients develop a flexion, adduction and external hip rotation deformity, due to contraction of the iliopsoas and other muscles. In some instances the disease has an acute onset closely resembling that of acute rheumatic fever. The sedimentation rate of the red cells is rarely increased. The B.M.R. is below normal in about 30% of cases. Radiographic examination reveals cyst-like structures in the bones of the joint surface, which result in erosion of the joint cartilage, with secondary osteophytic outgrowths.

Course and Complications. Several joints may be affected, and one or more of them may be completely immobilised. The smaller joints of the fingers may be involved, especially in middle-aged women, with development of Heberden's nodes at the proximal ends of the distal phalanges. At the climacteric, osteoarthritis may occur in the knees, associated with obesity.

Differential Diagnosis. This is as for rheumatoid arthritis. Limitation of external rotation and abduction of the hip joint distinguishes a case of osteoarthritis of the hip from sciatica. Acute osteoarthritis can usually be distinguished from acute rheumatic fever by the failure of response to salicylates.

Prognosis. This is unfavourable as regards recovery, but the disease seldom progresses to a stage of complete crippledom.

Treatment. Massage and radiant heat increase the vascularity of the structures around the joint and may help to relieve pain. The joint should be rested as much as possible, the patient lying down if the knees or hips are affected for at least an hour daily. No strain should be put on the affected joints, but they should be put through their full range of movement two or three times a day. Exercises which produce discomfort lasting for more than 2 hours are excessive. If the patient is obese, and the knees and hips are involved, dietetic restrictions should be imposed. Thyroideum $\frac{1}{2}$ to 1 gr. (80 to 60 mg.) t.d.s. is of value in cases associated with obesity or the climacteric. Gold salts are of no value. Physical treatment such as deep X-rays, diathermy and paraffin wax baths, may afford some relief from pain. It is doubtful whether intra-articular injections of hydrocortisone acetate, 25 mg., are of value. Indomethacin (Indocid) is preferred by some patients to a placebo, but it may have many side effects. In some cases phenylbutazone (Butazolidin) (see p. 653) diminishes the pain. In addition, if only one joint such as the hip is involved, operative measures may be considered, such as moving the joint under an anæsthetic, osteotomy of the femur to correct deformity, division of contracted muscles, removal of foreign bodies from the joints, excision of the bony outgrowths which are preventing movement (cheilectomy), vitallium cup arthroplasty and arthrodesis. Surgical appliances such as Thomas' walking caliper, will take the weight of the body from the pelvis off the hip.

Osteoarthritic Spondylitis

(Hypertrophic Spondylitis)

Pathology. Degenerative changes occur in the spine, similar to those described under osteoarthritis.

Clinical Findings. Although osteoarthritic changes are present in the spine in the majority of people over the age of 50, they rarely give rise to symptoms. The chief symptoms are root pains, some rigidity of the spine and muscular atrophy. When the cervical spine is involved there may be pain in the shoulders, neck and arms with limited spinal movement and Horner's syndrome (see page 149).

Treatment. This includes rest to the spine, heat, massage and in some cases a spinal support.

Ankylosing Spondylitis

(Atrophic Spondylitis. Von Bechterew's Disease. Strumpell-Marie Disease. Spondylose Rhizomélisque)

Definition. A rheumatoid type of arthritis affecting the spine.

Etiology. This is uncertain, but it is usually considered to be the same as for rheumatoid arthritis. A pelvic infection has been postulated.

Predisposing causes: 1. Age: 20 to 30 years. 2. Sex: Males predominate. 3. It tends to run in families.

Pathology. There is synovitis of the posterior intervertebral joints, with osteoporosis of the vertebral bodies. The sacro-iliac and costovertebral joints are often affected. Calcification occurs in the ligaments of the spine, and in the lateral borders of the intervertebral discs. The spine thus becomes rigid, the bamboo spine (see Fig. 64).

Clinical Findings. The onset is usually insidious with pain and stiffness in the back, especially on waking in the morning. Root pains may occur in the arms or legs, or girdle pains around the chest or abdomen. In a few cases there is an acute onset with fever.

On Examination: There is rigidity of the back (poker back), the spine may be curved with kyphosis in the upper thoracic region. In the early stages there is considerable spasm of the erector spinæ muscles. Flaccid paresis of the legs may occur from root pressure, with paræsthesia, or compression of the spinal medulla (cord) may give rise to spastic paralysis. There may be acute pain on percussion over the lateral spinous processes. Later the patient may be unable to stand upright, to turn without moving the whole body, or to take a deep breath. There are no rheumatic nodules. The sedimentation rate of the red cells is increased. X-ray examination shows decalcification of the bodies of the vertebrae, the joint spaces are not usually narrowed until late in the disease. The spinal ligaments are calcified.

Differential Diagnosis. The diagnosis is established by the X-ray examination of the spine. Changes are first seen in the sacro-iliac joints. If there are no bony changes the stiffness is usually due to fibrositis, of which chronic gonorrhœa may be the cause. A spinal

tumour or syphilitic meningitis may cause similar symptoms, but there are no bony changes. The pain may suggest gall-bladder or renal disease, scoliosis, pleurisy, Pott's disease or sacro-iliac strain.

Course and Complications. The course is usually slowly progressive. Respiratory complications, such as bronchitis, render the outlook more unfavourable. Pulmonary tuberculosis occurs in about 25% of cases. The hips, shoulders, temporomandibular, sternoclavicular and manubriosternal joints may all be affected. Extraskkeletal lesions may cause iritis and carditis.

Treatment. The general treatment resembles that advised for rheumatoid arthritis. A spinal brace should be worn to relieve the strain on the back. Phenylbutazone (Butazolidin) 100 mg. tab. t.i.d. in courses of 2 to 3 weeks, repeated after 2 weeks interval, often relieves pain. Breathing exercises are of value. X-ray treatment is dangerous and should not be used, as it may cause aplastic anemia or transverse myelitis.

Specific Infective or Toxic Arthritis

The inflammation of joints is here due to infection with known organisms, or occurs as a complication of infective diseases. This group includes pneumococcal, tuberculous, gonococcal, staphylococcal and streptococcal arthritis, acute rheumatic fever and arthritis associated with syphilis, dysentery (bacillary), brucellosis, dengue, typhoid fever, cerebrospinal fever, scarlet fever, measles and mumps.

Other varieties of arthritis are as follows: Metabolic, as in gout, Hæmorrhagic, as in purpura and hæmophilia. Nervous, as in Charcot's joints, or in syringomyelia. Anaphylactic, as in serum disease. Associated with deficiency diseases, such as rickets or scurvy. Psoriatic arthritis. This may be rheumatoid arthritis complicated by psoriasis. It is said that the terminal interphalangeal joints are especially liable to be affected. This is not always so. Traumatic and intermittent hydrarthrosis. Here periodical swelling occurs in joints, especially the knees and wrists. There is considerable weakness, but little pain. The swelling usually subsides in 2 to 3 weeks. It is possibly allied to angio-neurotic oedema.

Treatment consists in rest and firm bandages, together with drugs appropriate for the causative condition.

Reiter's Disease

This syndrome consists of polyarthritis, non-specific urethritis and conjunctivitis. There may be fever and diarrhoea, with blood in the stools at the onset. By some it is thought to be due to bacillary dysentery. The urethritis may be improved by the administration of tetracycline (Achromycin), 250 mg., every 6 hours for 5 days.

Subacromial Bursitis (Subdeltoid Bursitis)

Definition. Inflammation of the subacromial bursa which lies between the capsule of the shoulder joint and the deltoid muscle.

Etiology. Various causes are assigned. 1. Trauma. Injury to the supraspinatus or infraspinatus muscle from over-use or from hyperabduction of the arm. Injury to the shoulder by falling on the outstretched hand. 2. Lack of movement of the shoulder. This is liable to occur when, for example, a patient is confined to bed for several weeks owing to coronary thrombosis. 3. Pinching of the supraspinatus tendon between the acromion and the head of the humerus. 4. Secondary to a focus of infection, as at the root of a tooth. Often no cause can be found.

Pathology. The subacromial bursa is inflamed. It does not communicate with the shoulder joint. Calcification may occur in the wall of the bursa or in the supraspinatus or infraspinatus muscle tendons. Fluid may form in the bursa. The long tendon of the biceps may become adherent in the intertubercular groove of the humerus.

Clinical Findings. The onset may be sudden with acute pain in the region of the deltoid muscle, made worse on abducting the arm. The pain may extend down the arm to the elbow or even to the forearm. The pain is worse at night, it may encircle the arm at the level of the axillary (circumflex humeral) nerve, like a fiery wire, preventing sleep. Some relief may be obtained by lying flat on the floor.

On Examination: If an attempt is made to abduct the arm, after moving it about 20° from the side there is excruciating pain at the insertion of the deltoid into the humerus. All the movements of the shoulder are limited and the patient, if a male, cannot put his hand into his trousers' pocket. The patient has difficulty in placing the hand on the affected side behind his back, and he cannot raise the hand and forearm to a horizontal position behind his back.

Differential Diagnosis. The typical limitation of movement, and the hand-back test are characteristic. X-ray examination of the shoulder joint will exclude fracture or disease of the shoulder joint; and may reveal calcification in the tendons or bursal wall, as mentioned above.

Course and Complications. The condition may last for weeks or months unless properly treated. The chronic variety is known as "frozen shoulder".

Prognosis. With correct treatment the condition usually clears up completely.

Treatment. Any attempts at active movement cause extreme agony and lead to the formation of adhesions. Dry heat, electrical treatments and massage are equally bad. The affected shoulder should be immobilised by strapping the upper arm to the chest wall, and supporting the forearm in a sling. This usually quickly relieves the pain. The strapping should be removed after a week. The fear of allowing adhesions to form by immobilisation is groundless. If there is fluid in the bursa immediate relief from pain may sometimes be obtained by aspirating a few ml. through the deltoid muscle. Aspirin in large doses or phenylbutazone (Butazolidin) in small doses (see p. 653) are useful in cases in which pain is not relieved by immobilisation. Alternatively, a short course of deep X-ray treatment may prove efficacious, or hydrocortisone injections 25 mg., at weekly intervals.

cortisone, have been proposed as members of the collagen group. If these diseases, such as ulcerative colitis, Henoch's purpura, serum reactions, nephrosis, etc., are all accepted, there is a danger that the classification will become meaningless, a new name being added to medical science, without any corresponding enrichment of medical knowledge.

Corticosteroids may exert a deleterious effect in infections owing to their properties of inhibiting phagocytosis, increasing necrosis and caseation, and interfering with the formation of granulation tissue. Clinically, however, it has been found that corticosteroids are of value in the treatment of certain infections with or without the use of sulphonamides and antibiotics. Amongst these conditions may be listed brucellosis, typhoid fever, toxic pneumococcal pneumonia, some cases of very toxic pulmonary tuberculosis, virus hepatitis with prolonged obstructive jaundice, severe infectious mononucleosis, mumps orchitis, and neural leprosy.

Rheumatic Fever

(Acute Rheumatism)

Definition. An acute disease characterised by fever, joint pains and a liability to carditis.

Etiology. Rheumatic fever is due to infection through the throat, and possibly through the intestine, with any group A hæmolytic streptococci, the organisms passing by the blood stream to the sites of election, the heart, the joints, subcutaneous tissues and meninges. Some authorities believe that streptococci lodged in sites such as the tonsils, produce a chronic allergic state, which on stimulation results in acute rheumatism. *Predisposing causes:* 1. Familial diathesis: The disease runs in families, and the case incidence points to contact infection. 2. Age and sex: Children and young adults are chiefly affected, females preponderating somewhat in childhood, and males later. 3. Social factors: Overcrowding, poor food (possibly lacking in vitamin C) and damp houses are of importance. 4. Climate and season: Rheumatic fever prevails chiefly in temperate climates, in England especially in the autumn and spring, and epidemic years occur. Statistics tend to show that the incidence of rheumatism in children corresponds closely with that of rainfall. 5. Previous attacks: These predispose to subsequent ones. A history of tonsillitis, 1 to 3 weeks previously, is found in 50% of the cases. There has been a steady decline in the incidence during the last 40 years, due to improvements in social conditions and the use of antibacterial agents. 6. It may be an auto-immune disease, but there is little evidence to substantiate this view.

Pathology. It is not definitely known if the causative organisms circulate in the blood and settle in the joints and heart, or whether the lesions are due to a toxæmia, the organisms present from time to time in the blood and tissues being secondary infective agents. Post-mortem: The heart. Pericarditis, dry or with effusion, may be present. Aschoff's

sub-miliary nodules may be found microscopically in the myocardium. They are spindle-shaped and contain connective tissue cells and fibroblasts. Small sessile vegetations may be seen on the valves, such as the mitral or aortic valve. Subcutaneous nodules felt before death may not be found at autopsy; these are due to an inflammatory exudate, but in some cases they are fibrosed and then persist after death. Streptococci have been grown from the pericardium, from the affected heart valves and from subcutaneous modules.

Clinical Findings. The patient is usually a child or young adult. The first attack is said to occur under the age of 15 years in 90% of cases. In children the onset is often insidious. Many children suffer from subacute rheumatism, the chief symptom of which is so-called growing pains, which come and go and are felt in the limbs or back. They may also complain of attacks of abdominal pains. If the patient is an adult, he may have noticed an attack of acute pharyngitis 4 or 5 weeks previously, with malaise and fleeting limb pains. He is then suddenly seized with acute pain in one or more joints or in the præcordium. A history of similar previous attacks may be given.

On Examination: The patient is usually pale and not infrequently has auburn hair. Sweating is a characteristic feature; a sudaminal rash may be seen and the sweat has a rather sour smell. The tonsils are often unhealthy; enlarged, pitted or fibrosed. Usually the larger joints are affected, such as the ankles, knees, elbows and shoulders. They may appear normal or be definitely swollen. This swelling is due either to periarticular œdema or to fluid in the joints. Fluid removed from a distended joint is usually sterile. The skin over the joint is either normal in colour or a little red and hot, and there is tenderness on palpation, any attempt to move the joint causing very severe pain. The changes may spread rapidly from joint to joint, one improving as another is involved. In children only one joint may be affected. This is painful and usually swollen. The temperature is usually over 100° F. (37.8° C.), and rises as fresh joints are affected. Afebrile periods may occur, during which the pulse remains frequent. The heart: Rheumatic carditis is present in almost every severe case of rheumatic fever, although clinical evidence of this may be lacking in some instances. If there is no cardiac enlargement and no murmur is heard there is no clinical evidence of cardiac involvement. The rate of the heart, the position of the apex and the presence or absence of murmurs should be recorded daily, together with the character of the heart sounds. Special attention is paid to the tone of the first sound at the apex and whether or not the second sound is reduplicated there. The electrocardiogram may show evidence of heart block, myocarditis, or pericarditis.

The urine is diminished, high coloured, and may contain a trace of protein. The blood: Culture is usually sterile. There is a leucocytosis in the acute stages and anæmia may rapidly appear. The rate of sedimentation of the red cells is increased during the active stages of the disease. An abnormal protein, the C-reactive protein, is found in the serum. It is not specific for rheumatic fever, but is an indication of an inflammatory disease, and it varies with the activity of the disease. The antistreptolysin titre is increased and rises during the course of the disease, the normal value being about 100 units.

Differential Diagnosis. Acute rheumatism must be distinguished from other forms of acute infective arthritis such as acute osteoarthritis and acute rheumatoid arthritis, and from gout; the response to salicylates in acute rheumatism is a good therapeutic test.

In children acute rheumatism may be diagnosed when in reality the illness is due to osteomyelitis; in the latter the pain and tenderness are near to, rather than in, a joint and they are localised to one spot. Scurvy and poliomyelitis, owing to the pain or immobility of the limb, may also lead to confusion, if the patient is not examined thoroughly. In some cases abdominal pain and vomiting are mistaken for acute appendicitis, and an unnecessary operation performed.

Course and Complications. The course is usually rapidly modified by the administration of salicylates, the temperature falling to normal in a week or 10 days. There is a tendency for the pains to pass from joint to joint and for symmetrical joints to be affected. Relapse may also occur with a rise of temperature and recurrence of pain in the joints previously affected. The heart is the danger spot in acute rheumatism; the apex beat may pass outwards a little owing to dilatation, a soft apical systolic murmur being heard, due to dilatation of the mitral valve. This probably indicates some myocarditis. Rheumatic carditis may be definitely diagnosed if there is cardiac enlargement, a systolic murmur at or near to the apex, an accentuated pulmonary second sound and an accentuated first sound at the apex. The apical murmur is pan-systolic and conducted to the axilla, usually blowing and high-pitched, but it may be soft. There may also be a mid-diastolic murmur near the apex. An aortic diastolic murmur also indicates carditis. Pericarditis or pericardial effusion may develop. Other complications include chorea, and hyperpyrexia (cerebral rheumatism), the temperature rising to over 107° F. (41.6° C.). Rheumatic pneumonitis and pleurisy are rare complications. The important sequelæ are cardiac lesions, such as chronic endocarditis, usually of the mitral valve, leading to stenosis, especially in females, or affections of the aortic valve such as regurgitation especially in males. Pericardial adhesions may result from pericarditis. Subsequent attacks of rheumatic fever are not uncommon. No permanent joint damage results.

Prognosis. The disease is rarely immediately fatal, but death may occur from congestive failure. Chorea is an unfavourable complication. The ultimate prognosis depends upon the presence and severity of the cardiac lesions.

Treatment. *Prophylactic.* Acute streptococcal tonsillitis should be

treated with penicillin. Unhealthy tonsils should be removed and the teeth well cared for; damp clothes should be changed as soon as possible.

Curative. The patient should be put to bed between blankets or woollen sheets, and kept lying down with only one pillow. He must remain thus in bed until the temperature has been normal for 8 weeks after the salicylates have been discontinued, providing there is no cardiac affection. The sleeping pulse rate and the sedimentation rate of the red cells must also be normal. After this additional pillows may be given, and the patient gradually got up, providing the pulse rate is not accelerated or the temperature raised. If the heart is involved he should be kept in bed for a minimum of 8 months. Benzathine penicillin, 600,000 to 900,000 units, should be injected intramuscularly for 10 days, or oral penicillin may be given, 200,000 units tab., 4 q.i.d. a.c. for 10 days. If the patient is sensitive to penicillin erythromycin 250 mg. tab., one q.i.d. should be given for 10 days. This should be followed by sulphadiazine, 0.5 G. tab. b.i.d. p.c. for five years to prevent recurrence of the disease. Sod. salicyl. 15 gr. (1 G.), sod. bicarb. 30 gr. (2 G.), syr. aurant. 30 m. (2 ml.), aq. ad $\frac{1}{2}$ fl. oz. (15 ml.) should be given every 3 hours for 4 doses and then every 4 hours. When the effect of the drug is produced, as shown by relief of pains and fall in temperature, the dosage is reduced to six-hour intervals and then to 3 times a day. The average dose required is 1 gr./1 lb. body weight (132 mg./kg.) every 24 hours, and the blood salicylate concentration should be kept at about 30 mg. per 100 ml. Alternatively soluble aspirin 60 gr. (4 G.) in 24 hours in divided doses, can be given for a child of 10 years, and larger doses for an adult. It is easy to raise the plasma salicylate content to the effective level, but it is difficult to maintain it there, as it tends to fall although the same dosage is given. The dose must often be increased to prevent relapse. It is possible that salicylates may precipitate cardiac failure. If toxic symptoms occur, such as marked buzzing in the ears, nausea, vomiting or hæmaturia, or if the pulse falls below 60, it should be further reduced or discontinued, and prednisone prescribed either alone or with a small dose of salicylate. The initial dose of prednisone is 15 mg. q.i.d., reduced when a satisfactory response is obtained to 10 mg. q.i.d., and then gradually tapered off after about 6 weeks. Prednisone should also be given in severe cases, especially when carditis is present. Some children prefer aspirin to sod. salicylate.

Subsequently a child must not indulge in competitive sports. If dental extraction or tonsillectomy is required, 300,000 units each of penicillin G. and procaine penicillin should be injected 1 hour before the operation, followed by 300,000 units procaine penicillin 12 hours later.

Rheumatoid Arthritis

(Atrophic Arthritis)

Definition. Inflammatory and degenerative joint changes of doubtful etiology.

Etiology. In some cases the disease appears to be related to an infective focus at the roots of teeth, in the nose, throat, paranasal sinuses, bronchi, intestine or genito-urinary tract. *Predisposing causes* : 1. Age : Chiefly between 20 and 45. 2. Sex : Females predominate. 3. Exposure to cold and damp : The disease is practically unknown in the tropics. 4. Fatigue, overwork and mental strain. 5. Dietetic and endocrine deficiencies. Selye produced arthritis in adrenalectomised rats by injections of desoxycorticosterone. Hench drew attention to the remissions which occur during pregnancy or in jaundice. There is some disturbance of steroid metabolism. Progesterone is excreted mainly as pregnanediol. When progesterone is given to a patient suffering from rheumatoid arthritis, an abnormally high amount of pregnanediol is excreted.

Pathology. Rheumatoid arthritis is considered to be one of the collagen diseases but autoimmunity may be concerned with its etiology, and from time to time organisms have been found in joint fluid. The small joints of the hands are especially involved. There is peri-articular swelling, and in the early stages excess of fluid in the joints, hyperæmia, lymphocytic infiltration of the joint tissues, and later overgrowth of the synovial membrane with villous projections. Decalcification of bone may be followed by destruction of cartilage, and later dislocation with bony ankylosis may ensue. A rapid atrophy of the small muscles of the hands, and of the larger muscles, such as the extensors of the knee and wrist may occur when the fingers, knees or wrists are affected. Fibrositic changes are also common in the neighbouring muscles. Subcutaneous nodules occur in about 10% of cases. These consist of an area of central necrosis surrounded by large mononuclear cells and an envelope of fibrous tissue. Vasculitis is frequently found, periarteritis or intimal thickening, and sometimes the veins are affected.

Clinical Findings. It should be realised that the disease is a general one with local joint manifestations. There is usually a prodromal period of fatigue, often accompanied by loss of weight. The patient then notices pain and stiffness, especially on waking in the morning, around a metacarpophalangeal or interphalangeal joint. This is followed by increased pain and swelling of the affected joint or joints. The hands and feet are often cold. Later, the wrists, elbows, knees, ankles, cervical spine, shoulders, temporomandibular or other joints are affected. A periodicity of a few weeks is noticed in some cases between the appearances of fresh lesions. During the early stages acute exacerbations may occur from time to time, characterised by a throbbing pain disturbing sleep. The pain begins suddenly and the patient finds a small red thickening in the skin at the site of the pain, usually over an interphalangeal joint. The patient is very much disabled if the wrists and hands are affected and cannot exert any power in carrying, pulling or gripping, partly owing to pain but chiefly because of muscle weakness. When the disease is widespread the nights are usually worse than the days. The patient often cannot sleep for more than 1 to 2 hours at a time and is then awakened by the pain, frequently in the

shoulders or knees. Movement to a more comfortable position produces pain in many joints. The patient cannot lie on either shoulder if it is involved, and sleeps best semi-propped up. On waking in the morning there is much generalised muscle stiffness which takes some time to wear off.

On Examination: In the early stages a spindle-shaped deformity is seen, usually of the proximal interphalangeal joints, with swelling over the knuckles. Small fibrous nodules may be felt subcutaneously on the palmar or lateral aspects of the phalanges. Subcutaneous nodules may also be felt especially on the dorsum of the forearm. Later, if adequate precautions have not been taken, much deformity may develop in the hands, with ulnar deviation at the wrist and metacarpophalangeal joints, and, in advanced cases, inability to move or use the fingers or thumbs. The tissues around the wrists or other large joints, such as the ankles and elbows, may be thickened and pit on pressure, with limitation of movement. There is usually marked wasting of adjacent muscles, as described above. The skin of the fingers becomes thin, smooth and glossy. The joint lesions may be complicated by tenosynovitis and bursitis, especially around the shoulders, elbows, wrists, knees and ankles. Fixation of the elbows and marked deformity of the hands may prevent the patient from feeding or attending to himself, or lesser degrees of crippling may exist. The blood pressure is low. The supratrochlear and other lymph nodes are frequently enlarged, the spleen may be palpable, and there is irregular fever during the acute stages. In some cases signs of pericarditis are found, in others X-rays may show diffuse lesions resembling pneumonitis, or nodular lesions, or there may be a pleural effusion. The sedimentation rate of the red cells is increased with the activity of the disease. There is usually no leucocytosis, but secondary anaemia is common. The Waaler-Rose test is a serological test for rheumatoid arthritis. It depends on the presence of an antibody to non-specific groups of γ -globulin. The serum of patients with rheumatoid arthritis potentiates the agglutination of sheep erythrocytes sensitised with rabbit antboceptor. The test is said to be positive in over 90% of cases of rheumatoid arthritis, but false positives may occur in syphilis, disseminated lupus erythematosus and cirrhosis hepatis. The Latex test is another indication of the rheumatoid factor. The patient's serum agglutinates particulate carriers such as latex coated with denatured human gamma-globulin. X-ray examination usually shows decalcification of the carpal, metacarpal and phalangeal bones, cartilage may be eroded on the interphalangeal joints, or generalised decalcification may be present. Mental depression and irritability are often marked.

Course and Complications. The course of the disease is frequently interrupted by febrile exacerbations. Early and adequate treatment may effect arrest and considerable improvement, but in some cases, despite treatment, the course is progressive and the patient becomes completely helpless. Rheumatoid arthritis is associated with psoriasis in about 1% of cases and occasionally with Sjögren's disease (see also p. 15). Osteoarthritic changes may be superimposed on rheumatoid

arthritis in joints such as the knees. There may be acute rupture of the synovial cavity of the knee. Peripheral neuropathy affects chiefly the motor nerves. In oedema of the feet and ankles the oedema fluid has a low protein content.

Differential Diagnosis. A distinction is made from osteoarthritis, both by the clinical findings and X-ray evidence of bony overgrowth in the latter. Gout is differentiated by the absence of tophi or other uratic deposits, and by normal blood uric acid findings. Gonococcal arthritis is sometimes mistaken for rheumatoid arthritis. The favourable response of the former to penicillin differentiates. Palindromic rheumatism is a condition in which there are recurrent attacks of acute arthritis and peri-arthritis. The attacks appear and disappear suddenly. There is usually no fever.

Prognosis. With adequate and early treatment about 15% of patients may be "cured" and a further 85% improved. About 50% of patients remain stationary or get worse despite all forms of treatment.

Treatment. The patient who comes for treatment in the early, acute stage of the disease must be prepared for a long illness, and the most important part of the treatment is rest, local and general. The acutely affected joints should be placed in light splints, which should not be removed for 2 to 3 weeks. There is far less danger of adhesions forming in the joint if it is completely rested, than if the splint is removed daily and the joint moved. Subsequently for some weeks the splints can be worn at night. While the patient is in bed no pillow should be placed behind the knees, the weight of the bedclothes should be taken off the feet by a cradle, and only two pillows should be used for sleeping. During the day the unaffected joints should be put through their full range of movement. The patient should remain in bed, apart from getting up for "toilet" purposes, during the first 2 or 3 weeks, and then he should sit up in a chair for 1 to 2 hours daily, with gradual increments. The total period of rest treatment varies from 6 months to 1 year. Routine examinations include a blood count, estimation of the sedimentation rate of the red cells, the Waaler-Rose or latex test and the determination of the blood uric acid content. In some cases the latter is raised and treatment with colchicine is of value. The teeth and paranasal sinuses should be X-rayed, and care should be taken not to overlook bronchiectasis. Septic tonsils should be removed. If there is anaemia iron should be given in the form of tab. Fersolate 8 gr. (0.2 G.), 1 tab. t.d.s. p.c. After the preliminary three weeks, various local treatments may be ordered for the joints, such as gentle active movements, wax baths or contrast baths. Contrast baths are often helpful for hands or feet, which are put alternately into water at 105° to 110° F. (40.5° to 43.3° C.) for 1½ minutes and then into cold water at 60° F. (15.5° C.) for ½ minute, for 20 to 30 minutes. Passive movements generally do harm. A soluble aspirin preparation, such as Disprin, should be given regularly during the acute and subacute stages in doses of 15 gr. (0.9 G.) three or four times a day. If the pain is unrelieved tab. codein. co. may also be given once or twice daily. Gold salts may be dangerous, even if given in small doses, and the benefit obtained from them is doubtful. A fatal

result may ensue after even two or three small doses. Death may be due to exfoliative dermatitis, or to agranulocytosis and purpura, a sight horrible to witness. In my opinion gold should never be given.

If there is no marked improvement with aspirin after three or four weeks a corticosteroid drug should be used. The corticosteroids do not cure rheumatoid arthritis, but they exert an anti-inflammatory influence, usually with a rapid improvement of symptoms. There is a great diminution in stiffness on waking, increased freedom of joint movements, lessening of pain, increased muscular strength, disappearance of fever, fall in the sedimentation rate of the red cells, and a general sense of well-being accompanied by refreshing sleep. Certain unfavourable side-effects may ensue. These include retention of sodium with oedema, symptoms of Cushing's syndrome, a "moon" face, hirsuties, acne, osteoporosis, gastric irritation, mental excitation and psychotic states. Peripheral neuropathy is a very serious complication of steroid therapy. Severe symptoms of hypoadrenalism occur if the drug is withdrawn suddenly, and so it must always be gradually tapered off.

Contra-indications include peptic ulcer, renal disease, a psychosis, and, to a lesser degree, tuberculosis and diabetes mellitus. Should an infection, such as a boil, develop during corticosteroid treatment, the dose should be temporarily increased, and not diminished.

Cortisone is seldom prescribed now owing to its salt-retaining effects. The newer compounds are stronger, so that a smaller dose is required, and they have less salt-retaining properties. The equivalent values of these preparations are as follows: Cortisone 25 mg. \equiv prednisone or prednisolone 5 mg. \equiv triamcinolone 4 mg. \equiv dexamethasone 0.75 to 1 mg. \equiv betamethasone (Betnelan) 0.5 mg.

each course of treatment. Phenylbutazone can be given as a 250 mg. suppository, one or two at night, if there is gastric irritability. Phenylbutazone is dangerous unless given in small doses as it is liable to cause cedema, anæmia, or agranulocytosis. Contra-indications to phenylbutazone are cardiac damage, hypertension, renal or hepatic lesions, a history of peptic ulceration, of blood dyscrasias or of drug allergy.

Orthopædic treatment may be required to try and correct deformities in cases inadequately treated during the early stages. The patient should not be allowed to return to work until arrest has been secured, as judged by a normal temperature and sedimentation rate, a normal body weight, absence of swelling and stiffness and comparative freedom from pain in the affected joints.

Still's Disease

Definition. A variety of rheumatoid arthritis occurring in children, and characterised by swelling of joints, enlargement of the spleen and lymph nodes, with pyrexia. A similar condition may affect adults, when it is known as Felty's syndrome.

Clinical Findings. The disease usually begins before the second dentition. The parents notice swelling in the joints, usually in the hands, knees or wrists, and the child complains of pain and stiffness in them.

On Examination: The joints show periarticular swelling, the finger joints may be spindle-shaped, and movement of the joints is painful and limited. The wrists, knees, and cervical vertebræ may also be affected. Enlarged lymph nodes may be felt generally distributed and the spleen may be palpable. The muscles near the affected joints atrophy, the child is pale, sweats, and runs an irregular temperature of about 100° F. (37.8° C.).

Course and Complications. In the majority of cases the disease pursues an irregular course with remissions and exacerbations, and proceeds to a fatal issue from some intercurrent disease. Internal adherent pericardium may occur.

Prognosis. This is grave, but recovery has been recorded.

Treatment. The patient must be kept in bed during the active stages of the disease, and splints applied to prevent deformities. If the tonsils are infected they should be removed. The effect of aspirin or corticosteroids should be determined (see p. 653).

Systemic Lupus Erythematosus

The characteristic features are fever, polyarthritis, polyserositis, endocarditis, pericarditis, erythematous cutaneous lesions, nephritis, anæmia, a remittent cachexial course, with usually a fatal termination months to years after the onset. All these features are not necessarily present in each case. It frequently affects young women, 95% of cases being females. When endocarditis is a prominent feature the disease is known as the Libman-Sacks syndrome. No organisms are present in the verrucous endocarditis, the vegetations tending to spread over the valve surfaces and mural endocardium. Polyserositic manifestations are prominent in some cases, with ascites and pleural effusion. Such cases



FIG. 65. SYSTEMIC LUPUS ERYTHEMATOSUS SHOWING BUTTERFLY
DISTRIBUTION OF RASH ON FACE.

usually develop glomerulonephritis. The most prominent symptoms may be abdominal, with attacks of colic and symptoms of threatened obstruction. Portions of the small intestine are swollen and congested. There is usually a rapid response to corticosteroids. Convulsions may suggest epilepsy. The skin lesions assume a butterfly distribution on the face (see Fig. 65), and small red spots come and go on various parts of the body, such as the fingers, elbows, and on the scalp. The primary lesion appears to lie in the collagen tissue which serves as a matrix for the capillaries. The L.E. cells of Hargreaves are of some diagnostic value, but they are not always present in cases of systemic lupus erythematosus, and they are found in some cases of rheumatoid arthritis. They may be found in the blood or bone marrow. They are phagocytes, usually neutrophil polymorphonuclears, containing masses of chromatin which take a deep purple colour with Giemsa's stain. Auto-antibodies are found in some cases; they may be the result rather than the cause of the disease.

Corticosteroids or ACTH produce a remission of the symptoms, but in severe cases death usually occurs despite continuance of the treatment. The appearance of protein, red cells and casts in the urine may be the first indication of the true nature of the disease.

Generalised Scleroderma (*Progressive Systemic Sclerosis*)

Definition. A collagenous connective tissue disease in which there is progressive sclerosis of the skin and connective tissues. The mucous membranes, muscles, bones and internal organs may also be affected.

Etiology. The cause is unknown. The middle-aged are most commonly affected, and women more often than men.

Pathology. The collagen bundles in connective tissue swell and become dense and firm. In the intima of blood vessels there may be fibrinoid degeneration.

Clinical Findings. The patient notices pain, swelling or stiffness affecting the hands or feet, and the changes may spread to the face, limbs or trunk. In some instances dysphagia is one of the first symptoms, due to involvement of the œsophagus.

On Examination: In the early stages there is brawny œdema of the skin of the hands, feet, neck or trunk. The skin is white and puffy and does not pit on pressure. There is thickening of the skin, so that it cannot be pulled up from the underlying tissues. When the face is involved it becomes expressionless. Later, there is atrophy of the fingers and there may be ulceration at the tips. In some cases Raynaud's phenomenon is a prominent feature. Later, the skin becomes thinner and adherent to the muscles, the joints are fixed, the muscles are wasted, breathing is impaired and the patient may be described as a living mummy. Pigmented areas of skin are a feature in some cases, and malignant hypertension may result from renal involvement.

Differential Diagnosis. In the early stages scleroderma may be mistaken for rheumatoid arthritis, Raynaud's disease, or the localised

form of scleroderma, in which only the skin is involved. This is a comparatively benign disease, and is known as morphea.

Course and Complications. The disease is usually slowly progressive. The chief complications are bronchopneumonia and cardiac or renal failure.

Prognosis. Occasionally the disease is arrested, but usually it is fatal in about 5 to 10 years.

Treatment. Corticosteroids (see p. 653) should be tried. The underlying fibrotic lesions, however, are not affected by these drugs.

Dermatomyositis

Definition. A disease characterised by inflammation and degeneration of muscles, subcutaneous oedema and various forms of dermatitis. It is classified as a collagen disease (see p. 645).

Etiology. This is unknown.

Pathology. The muscles are oedematous, pale red or yellow. Areas of round-celled infiltration are seen in the muscles, with atrophy of the muscle fibres and thinning of the epidermis. Haemorrhages may occur (*Polymyositis haemorrhagica*).

Clinical Findings. The onset may be acute but is usually insidious, with pain or cramps in the muscles, anorexia, malaise and pyrexia. In some cases there may be dysphagia, diplopia, or difficulty in breathing. Symptoms and signs of pneumonitis may be the predominating features.

On Examination: Oedema of the face and eyelids may give the appearance of alabaster. Generalised oedema may occur. Various erythematous skin rashes may be seen. Occasionally there is eosinophilia. The spleen is enlarged and various muscles are tender, weak, wasted and often stiff. The diagnosis may be established by muscle biopsy.

Prognosis. Death occurs in about 60% of cases, and may result from involvement of the muscles of respiration.

Treatment. The patient must be kept in bed; massage and electrical treatment may be used, and the pain relieved by analgesics such as aspirin. In some cases the basal metabolic rate is low and good results are obtained from the administration of thyroideum, starting with $\frac{1}{2}$ gr. (15 mg.) daily and gradually increasing the dose. Temporary remissions are obtained in some cases by prednisone 5 mg. t.i.d. or by ACTH (Acthar Gel.) 30 to 40 i.u. intramuscularly twice daily, the dose being gradually reduced.

Acute Polyarteritis Nodosa

(*Periarteritis Nodosa*)

Definition. A condition characterised by a panarteritis of the medium-sized and small arteries, often with the formation of small aneurysms.

Etiology. Acute polyarteritis nodosa is probably a manifestation of hypersensitivity to various antigens especially to bacteria. Sulphonamides, organic arsenical preparations, iodine, thiourea and desoxycorticosterone acetate have all been reported as sensitising agents.

Pathology. There is a necrotising panarteritis with fibrinoid necrosis, affecting initially the media and subintima, periarteritis occurring as a secondary process. Healing occurs by granulation, scarring, and occasional aneurysm formation. The aneurysms may rupture. Sections of vessels are affected, and the vascular changes may occur only in the vessels of one system, or of one or two isolated organs. The arteries affected may supply the heart, kidneys, mesentery, liver, stomach, intestines, spleen, diaphragm, brain, lungs, muscles, or subcutaneous tissues.

Clinical Findings. The patient is usually a male between the ages of 30 and 40, but he may be a young child. The onset of symptoms is generally sudden, with fever, weakness, muscular or joint pains, vomiting and diarrhoea. In other cases there is a sudden onset with coma and convulsions, or the illness may be characterised by severe abdominal or cardiac pain, hæmoptysis, or hæmaturia. Bronchial asthma may be a prominent symptom. Urticaria and purpura may also occur. Asymmetrical peripheral neuritis (*mononeuritis multiplex*), involving one nerve after another, may be the most prominent symptom although symmetrical peripheral neuritis is more common.

On Examination: Small nodules may sometimes be felt on the subcutaneous arteries of the chest or abdomen. The urine may contain blood or protein. The blood pressure is raised in about 65% of cases. The temperature is usually raised, and the blood may show a leucocytosis of about 30,000 per c.mm. Subcutaneous nodules or eosinophilia are only found in about 20% of cases.

Differential Diagnosis. The nodules may suggest somatic tæniasis. The fever and abdominal symptoms may resemble those occurring in typhoid fever or in miliary tuberculosis. The nervous symptoms are liable to be mistaken for meningitis or a cerebral hæmorrhage. Acute renal pain may suggest a renal calculus or perinephric abscess. The hæmaturia suggests acute nephritis. Severe epigastric pain may suggest a perforated peptic ulcer. The dyspnoea with eosinophilia may be mistaken for asthma or, if the X-rays show transitory pulmonary infiltration, the condition closely resembles Loeffler's syndrome. It is rare for a correct diagnosis to be made before autopsy, unless the nodules are felt attached to the subcutaneous arteries.

Course and Complications. The disease usually pursues a progressive course lasting 3 to 4 months, but cerebral or perirenal hæmorrhage may cause sudden death.

Prognosis. The disease shows a mortality rate of about 50%.

Treatment. Penicillin, salicylates and cortisone have all been recommended. Cortisone or ACTH is chiefly of value in the acute cases. In hypertensive conditions it must be used with special caution.

Temporal Arteritis (Cranial Arteritis, Giant Cell Arteritis)

This condition resembles in many respects polyarteritis nodosa. Although it was originally stated that the changes in temporal arteritis

occur primarily in the adventitia, the condition is a granulomatous arteritis. In the media there is cellular infiltration with mononuclear and plasma cells, and giant cells. The intima is thickened, and there is gradual arterial occlusion. Temporal arteritis has been described in a case of polyarteritis nodosa. The changes are not limited to the temporal arteries, but may be seen in the occipital arteries and other branches of the common carotid, in the aorta and in the arteries supplying the viscera and the limbs.

Clinical Findings. Temporal arteritis affects adults after the age of 55 years. The first symptom may be tenderness on wearing a hat. There is often a prodromal stage of ill health, with loss of weight, malaise, night sweats and low grade fever. Later, the headache appears in the temporal or occipital region, it is severe and usually only relieved by morphine. It is not uncommon for the patient to complain first of ocular symptoms, usually blurring of vision, which may rapidly lead to blindness in one or both eyes. Ocular palsies may occur. The sedimentation rate of the red cells is raised, and biopsy of the temporal artery shows typical changes. Pericarditis has been described as a complication. The affected temporal artery stands out like a sinuous cord, it is tender and nodules may be felt in its thickened wall. The skin over it is red.

Treatment. Prednisolone should be given in large doses to prevent blindness, two 5 mg. tabs. q.i.d. for six months, the dose being gradually reduced after a month. The disease is usually self-limiting in a year or so, but if not treated the patient may go blind before this occurs.

Autoimmune Diseases

Introductory. An antigen is a substance which stimulates the cells of the body to produce antibodies. Antibodies or immune bodies are concerned with the destruction in the body of bacteria and foreign cells.

Antigens are usually introduced from without and are foreign to the animal or person inoculated.

An autoimmune disorder or disease is one in which an antigen is formed in the body which reacts with cells in an organ or tissue to form an antibody. Many tissues contain potential antibodies. The antibody causes destruction of certain cells or tissues, which are rejected as if they were foreign cells or tissues introduced from without. The source of the antigen is uncertain, but it may lie in damaged tissue cells.

Some authorities do not accept the theory of autoimmunity; they regard it as an airy fancy and "of imagination all compact."

Little is definitely known about autoimmunity and less about autoimmune diseases. Many talk glibly about an autoimmune disease, but when asked what is the evidence, little convincing is forthcoming.

The Role of the Thymus and Lymphocytes. The average weight of the thymus at birth, apart from fat and connective tissue, is 18 G. It increases in size until puberty and then atrophies. Castration delays its atrophy, and atrophy results from infections, X-ray radiations and the administration of corticosteroids. The average weight of the thymus at puberty is 22 G., at 25 years 10 G., at 30 years 6 G., and at 40 years 2 G. Normally the cortex is packed with lymphocytes, the medulla

contains reticulum cells, a few lymphocytes and the concentric corpuscles of Hassal.

The small lymphocytes are thought to play an important part in autoimmunity. The thymus lymphoid cells may migrate to form foci of lymphocyte production in other parts of the body. In early life the thymus is the chief site of lymphocyte formation and the primary source of the cells concerned with immunological reactions.

Small lymphocytes are also found in large numbers in lymph nodes and in the spleen. Many lymphocytes pass continually from the thoracic duct into the blood stream and so a circulation is continuously maintained. The germinal centres in the lymphoid nodules are probably concerned, not only with the formation, but also with the destruction of lymphocytes.

It is thought that the small lymphocytes are essential for a primary immune response, and that the antigen stimulates the small lymphocyte to change into a large lymphocyte, and then to a plasma cell which produces the antibody, a gamma-globulin.

The thymus is thought to be concerned with homeostasis. By homeostasis is meant the mechanism by which the formation of immunologically active cells, capable of reacting with body components, is prevented after birth. Thus, cells which have acquired the power of reacting antigens, when in accessible parts of the body can be destroyed in the thymus. It is the watch dog to prevent the development of autoimmunity.

There is evidence that the thymus system of cells is responsible for cellular immunity which leads to homograft rejection and delayed allergic reactions. In chickens, the bursa of Fabricius, a lymphoid mass situated just above the cloaca, controls the development of germinal centres and plasma cells in the lymphoid tissue of the spleen and in lymph nodes. It is responsible for the plasma cell series which secrete immunoglobulins and antibodies.

In mammals, such as the rabbit, it is thought that the lymphoid tissue in the appendix and Peyer's patches is analogous in function to the bursa of Fabricius.

Immunity reactions which result include antitoxin formation, protein precipitation, agglutination of bacteria and red cells, and bacteriolysis. Immune bodies are attached to gamma-globulin, and these protect the body against infection and invasion by foreign cells. When the lymphocytes die the immune bodies are carried away by lymphatics into the blood circulation.

In autoimmunity it is postulated that the antigen arises in the body. This is exemplified in Hashimoto's disease which is thought to be caused by thyroglobulin, normally shut off in the thyroid vesicles, escaping into the thyroid tissue where it reacts as a foreign antigen. In autoimmunity the body fails to differentiate between foreign cells and its own cells, between "self" and "not-self."

Autoimmune diseases may affect organs such as the thyroid, adrenal, heart or liver, and tissues such as those of the nervous system, striated muscle and circulating red cells. Females are usually more often affected than males.

Criteria of Autoimmunity. 1. The gamma-globulin serum level is above 1.5 G./100 ml. 2. Lymphocytes and plasma cells are aggregated in affected tissues. 3. The presence of L.E. cells (see p. 655). 4. Denatured gamma-globulin or its derivatives, including perhaps amyloid, is deposited in rheumatic nodules and renal glomeruli. 5. The presence of hæmagglutinins. 6. The demonstration of circulating antibodies, such as the rheumatoid factor (see p. 651).

Probable and Possible Autoimmune Diseases. Autoimmune diseases may occur without any apparent cause, or they may be manifest after some infection, following pregnancy, sunburn, or the taking of such drugs as the sulphonamides or phenylbutazone. There is usually dramatic but short-lived improvement with the administration of corticosteroids.

Hashimoto's disease. (See p. 704.) This is the stronghold of those who believe in autoimmune diseases. It is the one which is most completely documented and which fulfils the criteria laid down.

Thyroglobulin antibodies can be demonstrated by the tanned red celled hæmagglutination, by precipitation in agar gel, by immunofluorescence, and at times by the complement fixation. Further, the accredited antigen, thyroglobulin, is present outside and inside the thyroid vesicles and in neighbouring lymph nodes.

Systemic lupus erythematosus (see p. 654). The L.E. serum factor is a gamma-globulin which is thought to be produced in the patient's body and to react with a substance in the cell nucleus which results in the formation of the L.E. cell. It may therefore be called an antinuclear disease.

Autoimmune hæmolytic anæmia. A study of this disease led to the introduction of the term autoimmune disease. The hæmolysis results from the formation of globulin producing antibodies, which are attached to the patient's circulating red cells. There are warm and cold types. In the warm type the antibody is active at body temperature; in the cold type it is active a few degrees below body temperature. Clinical examples are afforded by the cold agglutins in virus pneumonia, and by paroxysmal cold hæmoglobinuria. The warm type is more common; it usually has an acute onset and there may be attacks of thrombocytopenic purpura with or between the hæmolytic episodes. The antibodies are demonstrated by the Coombs test (p. 519). The condition may also develop in the course of chronic lymphatic leukaemia.

Pernicious anæmia. Antibodies against parietal gastric cells have been found in the sera of over 80% of patients suffering from pernicious anæmia, but they are not diagnostic as they may occur in other conditions. An antibody to the intrinsic factor is, however, demonstrable in over 50% of cases and is more specific. It is also present in cases of latent pernicious anæmia in which there are no symptoms, as yet, of disease. The antibody is also present in the gastric juice.

Myasthenia gravis. In about 70% of cases the thymus contains numerous germinal centres and lymph follicles in the medulla, which do not normally occur. Serum gamma-globulins are present which react *in vitro* against striated muscle fibres and thymic epithelial cells in titres of 1 in 60 or more when examined by direct immunofluorescence

technique. This is the case particularly when there are thymoma tumours.

Rheumatic fever. The serum may contain anti-heart antigens when the disease is complicated by rheumatic carditis.

Rheumatoid arthritis. Hypergammaglobulinæmia is usually present, and a reaction may be obtained between the rheumatoid factor in the serum and an antigen derived from gamma-globulin.

Polyarteritis nodosa. This is also accompanied by hypergammaglobulinæmia.

Lupoid hepatitis. There is lymphoid infiltration of the liver, hypergammaglobulinæmia and, in some cases, antibodies are found in the blood.

Multiple sclerosis. The evidence in favour of it being an autoimmune disease is very shaky. There is no hypergammaglobulinæmia. A positive complement fixation test with the patient's serum and extracts made from the brain of a patient who suffered from multiple sclerosis may be positive in about 40% of cases.

Other conditions which have been thought to be due to autoimmunity include Sjögren's disease, idiopathic Addison's disease, ulcerative colitis, acute encephalopathies, dermatomyositis, macroglobulinæmia, hypergammaglobulinæmia, polyarteritis nodosa, polyneuritis and glomerulonephritis.

Conclusion. Much work yet remains to be done.

CHAPTER XII

DISORDERS OF METABOLISM

DEFICIENCY DISEASES

Introductory. Certain disorders are believed to be due to a deficiency or absence of a vitamin from the food. They are: Xerophthalmia, night blindness, rickets, beri-beri, rosacea keratitis, pellagra, scurvy, bleeding associated with jaundice, and neonatal hæmorrhage. Vitamins, or accessory food factors, are substances present in food which are essential for growth or health. Only minute quantities are necessary. They fall into two groups according to their solubility in fats or water. The following are described: *Vitamin A* (Growth Vitamin, anti-infective, anti-xerophthalmic). This is derived from green leaves, where it is probably synthesised with the aid of light. It can also be formed apart from the action of light. It is present in animal fats, in milk, butter, cod-liver and halibut-liver oil, etc., as the result of food eaten by the animal. It is found in traces only in vegetable oils. Deficiency of vitamin A in man may cause dryness of the skin and hyperkeratosis, night blindness and keratinisation of the epithelium in the eyes, lungs, genito-urinary tract and mouth, with a liability to secondary infections.

Vitamin D. (Anti-rachitic Vitamin.) This is present in animal fats such as cod-liver and halibut-liver oils, but butter is poor in it. It is present in vegetable oils. In human beings deficiency of this vitamin may cause rickets or dental caries, and overdosage results in irritability, anorexia, diarrhoea, excess of calcium in the bones and deposition of calcium in the kidneys. Success has attended the administration of large doses of vitamin D in the treatment of lupus vulgaris and of hypoparathyroidism.

Vitamin E. (Fertility or anti-sterility Vitamin.) This fat-soluble vitamin is present in olive oil, wheat embryo and green leaves. Wheat-germ oil is its most potent source. Four substances, α , β , γ and δ tocopherol have been isolated, each possessing vitamin E activity, but α -tocopherol is the most potent. It is essential for reproduction in rats, and without it chicks die from cerebellar degeneration and muscular atrophy. It has not been found useful in treating muscular dystrophy in man.

In 1965 further advances in our knowledge were made. Malabsorption of the vitamin may occur in steatorrhoea. After a latent period of about nine months the red cell membrane is damaged by peroxidases and hæmolysis may result, and in a patient treated by hyperbaric oxygen a hæmolytic attack occurred. The red cells showed a marked reaction to hydrogen peroxide.

Still later tocopherol deficiency may lead to the appearance of ceroid granules in the muscular coat of the intestines. Ceroid is a pigment

derived from oxidised unsaturated fat. This appearance seen at laparotomy, is known as the "brown bowel" syndrome.

The Vitamin B Complex. This vitamin has been divided into several factors. The following constituents have been isolated and synthesised; aneurine, riboflavin, nicotinic acid, pyridoxine, biotin, folic acid, p-aminobenzoic acid and panthothenic acid. It occurs in seeds, eggs, the germ bran of cereals including the husk of rice, and in yeast, meat, fish, milk, etc. Its presence in bread varies with the amount of wheat-germ used.

Vitamin B₁. This water-soluble vitamin has been isolated in pure form and also synthesised. The hydrochloride is known as aneurine or thiamine. Deficiency leads to beri-beri and possibly to certain types of peripheral neuritis in man and to polyneuritis in pigeons.

Vitamin B₂. This contains riboflavin (lactoflavin), and nicotinic acid. *Riboflavin.* Lack of this vitamin may be responsible for the glossitis and angular stomatitis met with in pellagra. Rosacea keratitis also responds to its administration in doses of 10 mg. t.i.d.

Nicotinic acid or Niacin (Vitamin P.P. or pellagra-preventing). In addition to its use in the prevention and treatment of pellagra, nicotinic acid is also used, on account of its vasodilator action, in the treatment of cerebral thrombosis, angina pectoris, and intermittent claudication. The serum cholesterol level can be lowered by taking 3 to 6 G. daily.

Vitamin B₆ (Pyridoxine, pyridoxal, and pyridoxamine). This is the anti-dermatitis factor in rats. It is used in the treatment of radiation sickness in doses of 20 to 40 mg. b.i.d.

Pantothenic Acid and Biotin. Pantothenic acid prevents greying of fur in rats. Biotin deficiency in rats causes a scaly dermatitis.

Folic acid. This is found in green leaves, spinach tops, yeast and liver. It is concerned with erythropoiesis and used in the treatment of certain megaloblastic anæmias, excluding pernicious anæmia.

Vitamin B₁₂. (Cyanocobalamin). This was isolated from the liver in 1948, 20 mg. of the vitamin being obtained from 1 ton of liver. For further information see pp. 444, 450, 522, 525.

Deficiency of the B complex causes pellagra and beri-beri, in both of which nutritional neuropathy may occur. Its main features are burning feet, retrobulbar neuritis and scotomata, nerve deafness, laryngeal palsy, and more rarely ataxia due to corticospinal or posterior column lesions. Some cases of Wernicke's encephalopathy have been described with vomiting and nystagmus as early symptoms, ophthalmoplegia and mental disturbances occurring later.

Vitamin C (Anti-scorbutic Vitamin). The following are particularly good sources of vitamin C:—Hips, haws, blackcurrants and Brussels sprouts. Vitamin C is ascorbic acid. Its deficiency causes scurvy in infants and in adults, and possibly faulty enamel formation in teeth.

Vitamin K. This is widely distributed amongst plants and a synthetic substance, menaphthone (2-methyl-1:4-naphthoquinone), is available for clinical use as menaphthone B.P. Its deficiency causes a diminution of prothrombin in the blood. It is valuable in checking hæmorrhage

associated with jaundice and neonatal hæmorrhage. There is deficient absorption of vitamin K when bile is absent from the intestine.

Vitamin P. This is present in Hungarian red pepper, lemon juice and orange peel. It is available for clinical use as Hesperidin tab. 150 mg. in the treatment of certain cases of petechial hæmorrhage.

Rickets

This is a generalised metabolic disorder of infants, with changes especially in the bones, due to deficiency of vitamin D in the milk and lack of sunlight. It has become very rare in the United Kingdom. The calcium content of the bones is low.

The earliest sign is craniotabes, which can be detected in a premature baby at the age of 1 to 3 months. In a month or so there is enlargement of the lower end of the radius, ulna and femur, beading of the costochondral junctions, and a depression running round the front of the lower part of the chest (Harrison's sulcus). Further changes include prominence of the sternum, bossing of the skull, delay in closure of the anterior fontanelle (normally closed in 18 months), curvature of the limbs and spine, enlargement of the liver and spleen, a low blood calcium and phosphorus, and increase in the alkaline phosphatase. X-rays show widening of the epiphyseal line in the long bones.

The child is irritable, and may suffer from sweating of the head, diarrhoea, bronchitis, convulsions, tetany or laryngitis stridulus. There is often delay in dentition.

Adolescent Rickets

(*Rachitis Tarda*)

Rickety manifestations appear at puberty, affecting only the long bones. The disease is associated with conditions of great privation. Adult rickets is exemplified by osteomalacia.

Treatment. *Prophylactic.* Expectant mothers should have a correctly balanced dietary. The baby at 3 weeks should be given a teaspoonful of cod-liver oil (4 ml.) or 6 drops of halibut-liver oil daily, and should be out of doors every day.

Curative. The child must be taken off his feet during the acute stage, and given liq. calciferol 5 m. (0.3 ml.) t.i.d. Overdosage with calciferol must be avoided, as the bones may become prematurely ossified and calcium be deposited in the kidneys.

The diet should include milk $1\frac{1}{2}$ pints (900 ml.) daily, in addition to rusks made from wholemeal bread, the yolk of an egg, orange juice, a little porridge, gravy, greens and steamed fish. Splints may be required for limb deformities.

Infantile Scurvy

Infantile scurvy is due to a deficiency of vitamin C in the diet, owing to the use of boiled or pasteurised milk. It first shows itself between the ages of 8 and 12 months. Hæmorrhages occur under the periosteum, there may be infarcts in the lungs or hæmorrhages in the intestines or

kidneys. The onset is insidious. Bruising may be seen on the face or body, petechiæ on the palate and hæmorrhage from the gums near an erupted tooth. A limb may appear paralysed owing to pain on movement. A tender swelling may be felt deep to the muscles, often near the lower end of the femur. Retro-orbital hæmorrhage may cause proptosis. *The blood:* The platelet count, bleeding time and coagulability are normal. There is some anæmia. X-ray examination may reveal a subperiosteal swelling, separated epiphysis or fracture. The urine may contain blood or protein.

Conditions which require exclusion are purpura, leukæmia, osteomyelitis, poliomyelitis, acute rheumatism, syphilitic epiphysitis, and a retro-orbital growth.

Treatment. *Prophylactic.* An infant should be given daily from birth 3 fl. oz. (90 ml.) of fresh orange juice, or 1 fl. oz. (30 ml.) of black-currant juice, or 1/3 fl. oz. (10 ml.) rose hip juice each of which contains 50 mg. ascorbic acid. *Curative.* Fruit juice should be given as above, and, in addition, ascorbic acid tab. 100 mg. t.i.d. by mouth.

Adult Scurvy

Scurvy may occur on long journeys, or in war owing to lack of fresh foods. It may also be met with in civil life in old men living alone, or in patients dieting because of peptic ulcer. There may be hæmorrhages from the gums and nose, in the muscles and under the skin. The teeth fall out.

Treatment. Ascorbic acid 0.5 to 1 G. (500 mg./5 ml. ampoule) should be injected intramuscularly t.i.d., followed by 500 mg. tab. by mouth b.i.d.

Beri-beri

(*Polyneuritis Endemica*)

Beri-beri is due to deficiency of vitamin B₁ in the diet, and there is often also lack of nicotinic acid and riboflavin. It occurs in countries in which the chief article of food is polished rice deprived of the pericarp which contains the vitamins.

In the "dry" form there is peripheral neuritis with weakness and wasting of the leg muscles, loss of deep reflexes, and areas of anæsthesia or hyperæsthesia. In the "wet" variety there is œdema of the legs, and fluid forms in the abdomen, pleura and pericardium. The right side of the heart enlarges. Wernicke's encephalopathy may also occur (see p. 663). The patient may die rapidly from heart failure.

Treatment. *Prophylactic.* Some of the husk of the rice should be left after milling, and wholemeal bread, yeast or Marmite eaten. *Curative.* Aneurin hydrochlor. 5 to 50 mg. should be injected intramuscularly daily for 12 doses, followed by 3 mg. by mouth t.i.d., together with yeast or Marmite.

Pellagra

Pellagra is thought to be due to lack of vitamin B₃ (nicotinic acid and riboflavin), vitamin B₆ (pyridoxine) and possibly vitamin B₁₂. It is

associated with diets rich in maize (deficient in tryptophan), but poor in meat and milk. It occurs especially in Italy and Rumania. It recurs in the springtime. There is redness and itching on exposed areas of the skin, which darkens and blebs may form. There is also soreness of the mouth or tongue, numbness or cramps in the legs, with spastic or flaccid paralysis. There is anæmia and often achlorhydria. Delusions or dementia may ensue.

Treatment. Nicotinic acid, 100 mg. tab., should be given 5 times a day, and a diet containing fresh milk, liver, eggs, fruit, and no maize. Riboflavin 10 mg. should be given t.i.d. for stomatitis, and aneurin. hydrochlor. 50 mg. injected intramuscularly for peripheral neuritis.

Famine or War Œdema

A condition of œdema of the legs may be met with amongst prisoners of war due to a lack of protein in the diet or retention of sodium in the tissue spaces. It is also occurs in civilian life when the chief article of diet is alcohol, and in some cases of anorexia nervosa. The plasma proteins are low and fluid passes by osmosis into the subcutaneous tissues.

Treatment. Blood transfusions of 300 to 500 ml. should be given twice a week and an adequate intake of protein ensured.

Kwashiorkor

This disease, which was described in the Gold Coast, has a wide distribution in Africa, Asia, the West Indies, South and Central America, and it has been met with in Italy and Hungary. It is common where malnutrition prevails amongst children. It is due to lack of protein in the food, and occurs usually between the ages of weaning and 4 years. The hair loses its pigment, becomes sparse and dry, and may be reddish or white. There is pallor, local or general œdema, enlargement of the liver, apathy, diarrhœa, and, as the disease progresses, a reddish rash consisting of hyperkeratotic patches which desquamate. The liver is fatty, and the pancreas fibrotic. The serum proteins are low. Treatment consists in transfusions of plasma, and the administration of skimmed milk, the fat content being increased as soon as possible.

Glycosuria

Glucose is found in the urine as the result of alterations in the secretion of the ductless glands, deficiency in the body storage mechanism, or lowering of the renal threshold for sugar.

Etiology. 1. *Affections of the Ductless Glands.* Pancreatic lesions causing deficiency in insulin as in diabetes mellitus or hæmochromatosis. Hyperthyroidism. Hyperpituitarism. Hyperadrenia.

2. *Cerebral Lesions*, such as tumours, hæmorrhage or meningitis, and experimental piqûre of the floor of the fourth ventricle. The glycosuria probably results from reflex stimulation of the adrenals and liver through the splanchnic nerves.

3. *Storage Deficiency.* The liver may not be able to store completely the ingested glucose as glycogen, with resultant hepatic glycosuria. A "lag" curve (see Fig. 66) indicates a defect in the storage mechanism, or an abnormally rapid absorption. In health it is very doubtful whether alimentary glycosuria can occur, i.e., glycosuria after a meal rich in carbohydrate.

4. *A Low Renal Threshold.* If the renal threshold for glucose is below the normal of 180 mg. glucose per 100 ml. blood, renal glycosuria (see Fig. 66) will ensue.

5. *Portacaval Anastomosis.*

6. *Stress.* Emotions. Physical strain. Infections.

7. *Pregnancy.*

8. *Multiparity.* Also in women who have produced babies of 10 lbs. or over.

9. *Insulin Antagonism.*

In all cases in which glucose is found in the urine, it is wise to determine the dextrose tolerance as this will indicate the severity of the condition.

Diabetes Mellitus

Definition. A disease characterised by glycosuria, hyperglycæmia and a disturbance of carbohydrate, fat, protein, water and electrolyte metabolism.

Etiology. Diabetes mellitus is due to a deficiency of insulin, the internal secretion of the pancreas, or in some cases perhaps to insulin antagonists. *Predisposing causes:* 1. Age: Diabetes occurs at all ages, but less commonly at the extremes of life, 80% of all cases are over the age of 40 years. 2. Sex: Females predominate. 3. Heredity: There is a tendency to a familial incidence, but the disease is not congenital. 4. Race: Jews are prone to diabetes. 5. Habits: Overeating, especially of fats, and lack of exercise. Eighty per cent of diabetic patients are obese when the disease is first discovered, but this does not apply to children. 6. Nervous shock: This is of doubtful significance. 7. Drug induced: As by the long continued use of thiazides.

Pathology. Insulin is derived from the inter-alveolar cell islets (islets of Langerhans). It is found in the β cells and was synthesised in 1963. It is destroyed by the digestive juices. In diabetes the blood sugar is above the normal range of 80 to 120 mg. per 100 ml. The sugar tolerance is diminished, as shown by the curve of blood sugar readings obtained after giving 50 G. of dextrose by mouth to the fasting patient, and estimating the blood sugar every half hour. Glucose is present in the urine, and acetone and diacetic acid may also be found there. *The pancreas:* It is usually thought that diabetes mellitus results from damage to the β cells of the inter-alveolar cell islets. The pathological changes, however, of fibrosis, hyalinisation and hydropic degeneration are only found to a marked degree in about 21% of cases, and in about 23% the pancreas appears normal. Glucagon, a protein substance, is produced in the pancreas, probably in the α cells. It causes hyperglycæmia. *The pituitary:* The well-known Houssay experiment showed that if a depan-

creatised dog is hypophysectomised the diabetes disappears and hypoglycaemia may ensue. If an injection of an extract of the anterior lobe of the pituitary is now made into such a Houssay dog, death will result from glycosuria and ketonuria. *The liver:* Usually no changes are found. The metabolism of carbohydrate, protein and fat is disturbed. The carbohydrate which is absorbed from the intestines in the form of monosaccharides (glucose, fructose and galactose) is not stored efficiently in the liver as glycogen, and is not used adequately by the muscles, but is excreted in the urine as glucose. Protein: The metabolism is disturbed, as the sugar portion of glyco-protein is excreted and not metabolised. Fat metabolism: Ketones result from incomplete oxidation of fatty acids.

Clinical Findings. The patient is usually an adult who seeks medical advice for such symptoms as general weakness, wasting, pruritus vulvæ, balanitis, thirst, polyuria, pains in the legs, boils and carbuncles, gangrene of a toe or constipation. In some instances failure of sight or impotence is first complained of, or the patient may be seen for the first time in a state of coma.

On Examination: The patient may be well nourished (*diabète gras*) or thin (*diabète maigre*). The tongue may be red and dry and the complexion high coloured. In the degenerative type of case the patient is usually over middle age and signs of cardio-vascular degeneration are present. The urine: The specific gravity is usually over 1.020, and the reaction is acid. A copper-reducing substance is present, as shown by Benedict's test. Special laboratory tests demonstrate that the substance is glucose. The "Clinistix" is a paper strip which turns blue when put into urine containing glucose. Acidosis may or may not be present, as shown by Gerhardt's ferric chloride test and the more delicate sodium nitro-prusside test of Rothera. The Acetest reagent tablet may be used. The blood: Sugar is present above the normal range of 80 to 120 mg. per 100 ml. in a specimen taken when the patient is not fasting; The amount of blood sugar present is usually proportionate to the severity of the disease. The Dextrostix strip may be used. The alkali reserve indicates the presence or absence of acidosis. The normal figure for the CO_2 capacity of the blood is 53 to 77 ml. CO_2 per 100 ml. plasma. With acidosis lower figures are obtained.

Coma due to Ketosis. Coma is very largely preventable. It may be caused by the patient taking too much carbohydrate, but more frequently it is due to an intercurrent infection which increases the amount of insulin required. Another cause is an attack of gastro-enteritis. The patient then makes the mistake of reducing the insulin or taking none at all as he is having less food, whereas really a larger dose of insulin is required. Trauma or a surgical operation may also precipitate coma. When a patient is ill the urine must be tested 3 or 4 times a day, to make sure enough insulin is being given. Diabetic coma does not come on suddenly, there are always warning symptoms. At the onset the patient may complain of abdominal pain, constipation, nausea, vomiting or restlessness. The chief clinical features during coma are air hunger (Kussmaul's type with slow and deep respirations), a smell of acetone in the breath, flaccidity of muscles, softness of the eyeballs, loss of deep

reflexes, tachycardia of over 120, a subnormal temperature, low blood pressure, a leucocytosis of 15,000 per c.mm. or over, the urine contains sugar and ketone bodies and the alkali reserve of the blood is low; the blood sugar is high. When there is renal failure the urine may not give the ferric chloride reaction although the breath smells strongly of acetone.

Differential Diagnosis. The reducing substance in the urine may not be glucose. Benedict's solution is reduced by glucose, fructose, lactose,

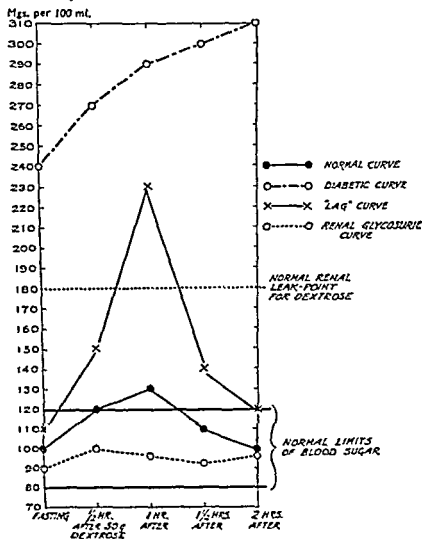


FIG. 66. CHART SHOWING DEXTROSE TOLERANCE CURVES.

pentoses, glycuronides and homogentisic acid. Reduction with Benedict's solution therefore indicates a derangement of carbohydrate metabolism with the exception of homogentisic acid, and the actual substance present can be identified by special tests. Glycosuria, however, does not necessarily mean diabetes. A blood dextrose tolerance test will decide whether diabetes is present and if so, its severity. Typical results are shown in the graphs given (see Fig. 66).

In renal glycosuria, although there is glycosuria, the blood sugar curve shows that the renal threshold is low, sugar appearing in the urine, although the amount in the blood is not above normal. Renal

glycosuria may rarely develop later into diabetes; a patient who has this condition should have a sugar tolerance test once a year; beyond this no treatment is required. A "lag" curve may be obtained. The sugar storage mechanism cannot keep pace with the dextrose absorption. Glycosuria occurs after a meal rich in carbohydrates and the blood sugar curve shows a fall to normal in 2 hours. A "lag" curve may also occur after gastro-enterostomy and in some cases of duodenal ulcer owing to rapid absorption of dextrose from the intestine. This condition may lead on to diabetes.

Renal glycosuria must be distinguished from pentosuria. In both conditions a substance is present in all specimens of the urine which reduces Benedict's solution, and the blood sugar and sugar tolerance curves are normal. Special chemical tests on the urine are required to distinguish between pentose and glucose, the simplest being the fermentation one. Pentose does not ferment yeast, whereas glucose does.

Coma due to ketosis must be differentiated from meningitis or cerebral hæmorrhage in which hyperglycæmia and glycosuria are often present. If the temperature is normal or above normal the case is probably not one of uncomplicated diabetic coma. *Nonketoadidiotic diabetic coma: hyperosmolar diabetic coma.* The patient is usually over 50. There is hyperglycæmia with dehydration, hæmoconcentration, and little or no acetone in the urine. There may be air hunger. The serum osmolarity, as calculated from the concentration of glucose and sodium, may be 403 and 366 milliosmoles per litre respectively, the normal being less than 300. The blood sugar may reach over 2,000 mg./100 ml. and the sodium is raised in over 50% of cases, as more water is lost than sodium. The blood urea is also raised. Focal seizures may suggest epilepsy. A good response is usually obtained with insulin and rehydration. *Lactic acid acidosis* with coma is also met with, there being a decrease in plasma bicarbonate.

Course and Complications. The course depends upon the type of disease present, mild or severe; in children it is usually severe, in elderly people mild. The course can be favourably modified by adequate treatment in the majority of cases. Complications include: Septic lesions such as boils, carbuncles, multiple abscesses in muscular tissues and streptococcal cutaneous or subcutaneous lesions. Chronic pyelonephritis is common. Insulin lipodystrophy, may occur at the site of insulin injections (see Fig. 67) especially in women and children. This may cause great mental and physical distress. The cause is unknown, as is also the cure. Atherosclerosis. The Kimmelstiel-Wilson kidney (see p. 488). Pulmonary tuberculosis. Gangrene of the lung. Peripheral neuropathy and amyotrophy. Myocardial degeneration, with symptoms of heart failure. Gangrene, especially of the toes. Coma, either hyper- or hypoglycæmic, the former being due to acidosis, the latter to overdosage of insulin. Cataract. Retinopathy. The small circular red spots seen in the retina, which were formerly called hæmorrhages, are due to micro-aneurysms on the capillaries. Korsakow's psychosis (see p. 794). Diabetes and pernicious anæmia may occur together.

Hypoglycæmia. The patient who is receiving insulin for the



FIG. 67. INSULIN LIPODYSTROPHY.

treatment of diabetes may suffer from hypoglycæmia. With soluble insulin this is particularly liable to occur if a carbohydrate meal is not taken within half an hour of the injection, or if the patient takes an undue amount of exercise. The early symptoms are sweating, flushing or pallor, hunger, headache, abdominal discomfort, weakness, tremors, visual disturbances and coldness of the extremities. Consciousness may be retained although the patient is unable to move or speak. The patient may vomit and become unconscious with marked convulsions resembling those of acute mania. Hemiplegia sometimes occurs with an extensor plantar response. Children may become pale and then suddenly pass into coma. The hypoglycæmic attack may not occur until about 4 p.m., i.e., after lunch, although no insulin has been given since before breakfast. The treatment is described later (see p. 678).

Prognosis. This is good in all mild types of disease; in severe cases the prognosis is usually favourable, provided the patient can be adequately treated and will be conscientious in his after-treatment. Given skilled stabilising treatment the prognosis largely depends upon the patient. Any septic focus may predispose to, or excite coma. Diabetes with tuberculosis in the past formed a serious combination. With the use of streptomycin, isoniazid and para-aminosalicylic acid in the treatment of tuberculosis, the diabetes is much more easily controlled. The insulin required often falls in patients who are meticulous in carrying out the dieting, and in some cases after 2 or 3 years no insulin is required. Death in young people is usually due to coma. Death in the elderly is usually due to cardio-vascular complications. The mortality rate has fallen in the young, but risen in old age in those who over-eat. Antibiotics have lowered the mortality.

Treatment. Stabilising Treatment. Except in very acute cases, in which it is essential to begin insulin treatment immediately, a dextrose tolerance test should be made, after giving the patient a diet containing 800 G. carbohydrate for 8 days. This will confirm the diagnosis of diabetes and give some idea of its severity. Mild cases in adults and diabetes in middle-aged obese patients may often be treated by dieting without insulin. In children, in severe cases in adults, and in any case in which complications are present, such as ketosis, peripheral neuropathy, diabetic retinopathy, gangrene of the extremities and pulmonary tuberculosis, insulin should be administered at once.

Starvation followed by graduated diets. This is seldom used now and only when the disease is mild or if the patient refuses insulin. No patient with ketosis should be starved, as there is a grave risk of precipitating coma. A patient who is being starved is put to bed and given fluids, such as water, lemonade sweetened with saccharin, Bovril, and weak tea or coffee without sugar or milk. The urine usually becomes sugar-free in about 36 hours. The patient is then worked up through a series of graduated diets until he is taking an adequate diet. The adequate diet is calculated by determining the number of calories required, on the basis of 15 cal. for 1 lb. (30 cal./kg.) "correct" body weight, and adding 10 to 20% more to the figure for the basal requirement diet, so obtained, according to the muscular work which will be

done when the patient is living a normal life. The "correct" body weight may be obtained from age, sex and height tables.

Insulin Treatment. The patient is given a diet, the caloric value of which depends upon the estimated requirements for his normal activities. This usually contains about 200 G. carbohydrate, 90 to 100 G. protein and 90 G. fat. The caloric value can be easily worked out, as 1 G. of carbohydrate equals approximately 4 cal., 1 G. protein 4 cal., and 1 G. fat 9 cal. An example of such a diet is as follows :—

Breakfast : Tea or coffee; Milk 4 fl. oz. (120 ml.); Bread, 2 oz. (60 G.); Oatmeal (dry), 1 oz. (30 G.); Butter, $\frac{1}{2}$ oz. (15 G.); Marmalade, $\frac{1}{2}$ oz. (15 G.); Egg, 1. C. 68.5 G., P. 21 G., F. 27 G. Cals., 581. 11 a.m. Tea or coffee; milk, 1 fl. oz. (30 ml.); plain biscuit, 1. C. 6.5 G., P. 1 G., F. 1 G., Cals. 88. Lunch: Fish, 3 oz. (90 G.); Potatoes, 2 oz. (60 G.); Bread, 1 oz. (30 G.); Butter, $\frac{1}{2}$ oz. (15 G.); Milk, 5 fl. oz. (150 ml.); Stewed apples, 4 oz. (120 G.); Cheese, (Cheddar), 1 oz. (30 G.); C. 35 G., P. 33 G., F. 27 G., Cals. 515. Tea: Tea; Milk, 2 fl. oz. (60 ml.); Bread, $1\frac{1}{2}$ oz. (45 G.); Butter, $\frac{1}{2}$ oz. (7.5 G.); Salad, if desired. C. 24 G., P. 5 G., F. 8 G., Cals. 188. Dinner: Clear soup, if desired. Lean meat, 3 oz. (90 G.); Potatoes (boiled), 2 oz. (60 G.); Butter, $\frac{1}{2}$ oz. (7.5 G.); Green vegetables, 2 oz. (60 G.); Bread, 2 oz. (60 G.); Milk, 7 fl. oz. (210 ml.); Cheese (Cheddar), 1 oz. (30 G.). C. 56 G., P. 45 G., F. 33 G., Cals. 701. Bedtime: Milk, 4 fl. oz. (120 ml.); Plain biscuits, 2. C. 16 G., P. 4 G., F. 4 G. Cals. 116. Total: C. 201., P. 109 G., F. 100 G. Cals. 2,189.

In hospitals, to which dietitians are attached, the diet will be supplied according to the patient's requirements, the actual distribution of carbohydrate between the four meals being varied according to whether soluble insulin is being given in 1 or 2 doses, morning and evening, or whether a combination of soluble insulin with protamine zinc insulin, a lente insulin, or isophane insulin is injected in one morning dose. The medical student and doctor should be familiar with the constitution and caloric value of the various food stuffs, so that they can draw up the diet, if necessary. In acute cases, and in children, better results are obtained by the use of high carbohydrate diets, containing 250 to 300 G. carbohydrate. The fat should be limited to about 90 G. and the remainder of energy required is supplied by protein.

The Administration of Insulin. It is not usually necessary for blood sugar estimations to be made daily during the preliminary stabilising treatment, providing the urine is tested regularly for sugar. The following routine may be employed : 8 a.m., urine collected and insulin injected if sugar is present. 8.30 a.m., breakfast. 12 noon, urine collected. 1 p.m., lunch. 3.30 p.m., urine collected. 4.30 p.m., tea. 7 p.m., urine collected and insulin injected if required. 7.30 p.m., dinner. 9 p.m., urine collected. The specimen passed before insulin is due must always be tested before insulin is injected. The insulin is gradually increased until the necessary amount is determined. Five units of soluble insulin are injected half an hour before breakfast and the insulin is increased 5 units at a time every 2 or 3 days until the midday specimen of urine is sugar-free. If now the 8 a.m. specimen of urine contains sugar, an evening dose of insulin is given half an hour before

Food Analyses

		G.			mg./100 G.		Cals.
		C.	P.	F.	Na.	K.	
<i>Farinaceous Foods :</i>							
Bread (white) . . .	1 oz.	14.3	2	0.4	393	70	69
Bread (brown) . . .	1 "	13	1.4	0.4	393	147	61
Toast (white) . . .	1 "	17.2	2.3	0.3	467	83	81
Toast (fairy) . . .	1 "	21	3	0.6	—	—	103
Energen bread (1 roll) .	—	2	1.5	0.25	—	—	16
Ryvita (3 sections) . .	1 "	21.2	3.3	0.4	613	469	105
Vitaweat (3 sections) . .	1 "	21.2	3.3	2.2	605	430	121
Rice (uncooked) . . .	1 "	22.7	1.6	0.1	6.3	113	98
Oatmeal (dry) . . .	1 "	18	4.6	2	33.4	368	108
<i>Dairy Produce :</i>							
Egg (1) . . .	2 "	0	7.6	4.8	76	130	74
Milk . . .	1 "	1.5	1	1	14	140	19
Butter . . .	1 "	0	0	25	780	60	225
Cream (20%) . . .	1 "	1	1	6	40	56	62
<i>Cheese</i>							
Camembert . . .	1 "	0	6.3	6.5	—	—	84
Dutch . . .	1 "	0	9.2	5.3	1,250	96	84
Wensleydale . . .	1 "	0	10	6	—	—	94
Gorgonzola . . .	1 "	0.5	7.8	8	1,220	172	105
Gruyere . . .	1 "	0	9.4	8.5	542	125	114
Cheddar . . .	1 "	0.9	10	8	540	130	116
Cheshire . . .	1 "	1.3	8.8	9.2	—	—	123
St. Ivel . . .	1 "	0	7.1	10.5	567	68	123
Roquefort . . .	1 "	0.5	10.4	0.4	—	—	128
Stilton . . .	1 "	0	7.2	11.7	1,150	161	134
<i>Preserved Meats:</i>							
Bacon (back, fried) . .	1 "	0	7.4	16	760	95	174
Bacon (streaky, fried) .	1 "	0	7.2	13.8	3,090	462	153
Ham (lean, boiled) . .	1 "	0	6.9	4	2,100	610	64
Tongue (ox, canned) . .	1 "	0	5.8	7	100	260	86
<i>Fresh Meat :</i>							
Rabbit (stewed) . . .	1 oz.	0	8	2.3	47	370	53
Hare (stewed or roast) .	1 "	0	8.8	2.4	40	211	57
Veal (cutlet, fried) . .	1 "	0	9.1	2.4	48	330	58
Beef (roast) . . .	1 "	0	8	3.7	70	357	65
Veal (fillet, roast) . .	1 "	0	9.2	3.5	53	380	68
Mutton (boiled) . . .	1 "	0	7.7	5	110	330	76
Mutton (roast) . . .	1 "	0	7.5	6.1	71	346	85
Pork (leg, roast) . . .	1 "	0	7.4	7	58	200	93
Pork (loin, roast) . . .	1 "	0	7.8	10.7	69	353	128
<i>Poultry and Game:</i>							
Grouse (roast) . . .	1 "	0	9	1.6	96	466	50
Chicken (roast) . . .	1 "	0	8.9	2.2	110	250	55
Turkey (roast) . . .	1 "	0	9	2.3	92	310	57
Chicken (boiled) . . .	1 "	0	7.9	3.1	98	381	60
Guinea-fowl (roast) . .	1 "	0	9.8	2.5	136	420	62
Partridge (roast) . . .	1 "	0	10.6	2.2	100	407	62
Pheasant (roast) . . .	1 "	0	9.2	2.8	104	411	62
Pigeon (roast) . . .	1 "	0	8	4	105	410	63
Duck (roast) . . .	1 "	0	6.8	7.1	96	210	91
Goose (roast) . . .	1 "	0	8.4	6.7	145	406	94
<i>Internal Organs :</i>							
Brain (calf, sheep, boiled)	1 "	0	3.5	1.9	150	340	31
Kidney (stewed) . . .	1 "	0	7.7	1.7	210	310	46
Sweetbread (stewed) . .	1 "	0	6.8	2.7	67	231	52
Kidney (fried) . . .	1 "	0	8.4	2.7	261	304	58
Liver (calf, fried after rolling in flour) . . .	1 "	0.7	8.7	4.4	110	250	77
Tongue (sheep, fresh, stewed) . . .	1 "	0	5.5	7.2	100	200	67

		G. mg./100 G.					Cals.
		C.	P.	F.	Na.	K.	
<i>Fish :</i>							
Oysters	1 oz.	0	3	0.3	73	110	15
Cod (steamed)	1 "	0	5.4	0.3	100	360	24
Sole (steamed)	1 "	0	5.3	0.4	110	240	25
Lemon sole (steamed) .	1 "	0	6	0.3	115	270	27
Plaice (steamed) . . .	1 "	0	5.4	0.6	120	278	27
Whiting (steamed) . .	1 "	0	6	0.3	225	112	27
Haddock (steamed) . .	1 "	0	6.6	0.2	121	323	28
Turbot (steamed) . . .	1 "	0	6.2	0.5	90	285	29
Haddock (smoked, steamed)	1 "	0	6.7	0.3	1,220	203	30
Hake (steamed)	1 "	0	5.5	1	118	310	31
Lobster (boiled)	1 "	0	6.4	1	325	258	35
Trout (river, steamed) .	1 "	0	6.7	1	88	374	36
Crab (boiled)	1 "	0	5.8	1.6	366	271	38
Halibut (steamed) . . .	1 "	0	6.8	1.2	56	540	38
Mullet (red, steamed) . .	1 "	0	6.5	1.3	118	364	38
Mullet (grey, steamed) .	1 "	0	6.5	1.3	94	275	38
Salmon (tinned)	1 "	0	5.9	1.8	538	320	40
Herring (baked in vinegar)	1 "	0	5	3.9	62	233	55
Salmon (steamed)	1 "	0	5.7	3.9	48	410	58
Kipper (baked)	1 "	0	7	3.4	990	520	59
Sardines (tinned) . . .	1 "	0	6.1	6.8	760	260	86
<i>Miscellaneous :</i>							
Pickles (mixed, unsweetened)	1 "	1.2	0.2	0.1	2,300	300	25
Olive oil	1 "	0	0	30	0.2	0.2	270
Whisky (25% alcohol) .	1 "	0	0	0	0.1	0.6	50
Lump sugar (8 lumps, $\frac{1}{4}$ -inch cube) . . .	1 "	30	0	0	0.3	0.5	120

dinner, and the dose increased by 5 units every 2 or 3 days until the before-breakfast specimen is sugar-free.

Soluble insulin (SI) is put up in strengths of 20, 40 and 80 units per ml. It has a rapid action, beginning about half an hour after injection, reaching its maximum in about 8 hours, and ceasing to have any effect in 6 hours. With soluble insulin breakfast contains the greatest amount of carbohydrate, dinner the next largest amount, with relatively little at lunch and tea. Not more than 50 units of soluble insulin should be given at a single injection, except in the treatment of coma. Soluble insulin is necessary for the treatment of hyperglycæmic coma, before or after surgical operations, in acute gastro-enteritis, and for children or young people in whom rapid changes occur in the level of the blood sugar.

Protamine zinc insulin (PZI) has a delayed effect, beginning about 6 hours after injection and lasting up to 24 hours or longer. It therefore tends to have a cumulative effect if daily injections are given, and is more likely to lead to hypoglycæmic coma than is soluble insulin. It is put up in two strengths, 40 and 80 units per ml. If zinc insulin is given the carbohydrate content of the food should be divided approximately equally between the four meals, and about 10 G. of carbohydrate taken at bedtime.

If protamine zinc insulin is injected before breakfast it is often found that the noon specimen of urine contains sugar, whereas specimens later in the day and in the early morning are sugar-free. In such cases soluble insulin should be injected before breakfast with the protamine zinc insulin, and the dose of soluble insulin should always be slightly greater than that of the zinc insulin. The two insulins are put in the same syringe and thus only one injection is required. Care must be taken to avoid mixing as far as possible the soluble and protamine zinc insulins in the syringe, as the soluble insulin is thereby converted into the zinc insulin. An amount of air equal to the volume of zinc insulin required is first injected into the zinc insulin phial. The needle is withdrawn and the required amount of soluble insulin is drawn into the syringe. The zinc insulin is now drawn into the syringe taking care that no air enters the syringe. The injection is now given. Owing to the slow rate of absorption of zinc insulin, it is useless for the treatment of coma associated with hyperglycaemia, for which soluble insulin alone is efficient.

Insulin zinc suspensions (IZS) do not contain protein. There are three varieties of insulin zinc suspension. I.Z.S. (amorphous), or semilente insulin, is effective for about 10 to 15 hours. I.Z.S. (crystalline), or ultralente insulin, has a delayed action, which persists for about 24 to 36 hours. I.Z.S., or lente insulin, consists of a mixture of three parts of amorphous and seven parts of crystalline insulin. This produces a fairly continuous lowering of the blood sugar for 24 hours after injection. The carbohydrate content of the food should be arranged so that the evening meal contains less than breakfast or the midday meal. If more than 50 units are required, it is better to use a combination of soluble insulin with protamine zinc insulin. The lente insulins are injected in the morning on getting up. Soluble insulins cannot be combined with insulin zinc suspensions. The vial must be well shaken and the injection quickly made. They seldom provoke local insulin reactions, being free from protein. They are not effective in severe cases of hyperglycaemia with ketosis, especially when there is intercurrent infection.

Isophane insulin (N.P.H.) is a crystalline suspension of insulin protamine sulphate and zinc. In doses of 40 units it may control the blood sugar for 24 hours, but in smaller doses its effect is shorter. It is best given morning and evening for insulin sensitive cases in which the reaction to soluble insulin is too marked, as shown by glycosuria and ketonuria for a few hours before the next injection. The lente insulins are not used so much as formerly, a return being made to two daily injections of soluble insulin, or to PZI insulin with soluble insulin.

Oral Hypoglycaemic Agents. Certain sulphonyl derivatives, especially the sulphonylurea preparations, have a hypoglycaemic effect when given by mouth. They are thought to stimulate the secretion of insulin. Tolbutamide (Rastinon) is put up in 0.5 G. tablets. The average dose for an adult is 2.5 G. the first day, 1.5 G. the second day, and then 0.5 G. morning and evening, to be taken with or directly after food. They have been found effective in controlling diabetes in the middle-aged or

elderly diabetic who has never had ketosis, and who needs less than 30 units of insulin a day. Tolbutamide is rapidly excreted, it may have to be discontinued after 2 to 4 years in about 25% of cases owing to the patient failing to respond to the drug, to abdominal pain or rashes, or to the patient gaining too much weight. Chloropropamide (Diabenese) is put up in 100 and 250 mg. tablets. The initial single daily dose is 250 to 500 mg. before breakfast, which is reduced to a maintenance dose of 100 to 250 mg. Tolazamide (Tolanase) is put up in 100 or 250 mg. tabs., and the dose is 100 to 250 mg. daily with breakfast. The biguanides, phenformin and metformin, are anti-diabetic. Their mode of action is uncertain and the side-effects are common.

When the patient is on a satisfactory diet a careful search should be made for septic foci in the mouth, nose and throat, etc., and, if found, they should be eradicated; a chronically inflamed appendix or gall-bladder may require removal, before the metabolic processes are properly stabilised.

Diabetic Treatment in case of Operations. If an operation is required it should be performed under a local anæsthetic, or with the aid of gas and oxygen, thiopentone, cyclopropane, etc. Chloroform and ether should never be given. The patient should be stabilised as described above and not starved before the anæsthetic. He should have his last meal 8 to 4 hours before the operation. Two and a half hours before the anæsthetic he should be given 80 units of soluble insulin and half an hour later dextrose 2 oz. (60 G.) dissolved in water 6 fl. oz. (180 ml.) by mouth. On recovery from the anæsthetic the patient is given dextrose 5 to 6 oz. (150 to 180 G.) by mouth or intravenously during the first 24 hours. Thus dextrose 2 oz. (60 G.) dissolved in water 6 fl. oz. (180 ml.) may be given 3 times during the 24 hours, with 10 to 20 units of insulin injected half an hour before each dose. No insulin should be injected unless the blood sugar is above 120 mg. per 100 ml., or if the urine is sugar-free. Four pints (2.4 litres) of fluid in all must be given during the first 24 hours, either by mouth or intravenously. The next day the patient will probably be able to take citrated milk feeds of 4 to 6 fl. oz. (120 to 180 ml.) every 8 hours with dextrose 1 oz. (30 G.) in three of the feeds. Half an hour before these dextrose feeds 10 to 20 units of soluble insulin should be injected. The urine must be tested for sugar before each insulin injection. The diet is then gradually increased.

Diabetes and Pregnancy. A diabetic woman can safely be allowed to become pregnant if she is properly treated. Further, pregnancy is more likely to occur in a diabetic who is under treatment with insulin than in one who is not being so treated. Still-birth is common in diabetes, unless the disease is accurately controlled. The blood sugar of an infant born of a diabetic mother is often low (4 to 22 mg. per 100 ml.) and hypoglycæmic convulsions may occur which are quickly relieved by the administration of dextrose. During pregnancy there is a tendency to ketonuria. When the patient is in labour, milk, dextrose and insulin should be given as described under the treatment in the case of operations. Cæsarean section is unnecessary. During the puerperium there is a tendency to hypoglycæmia and the insulin dosage may be reduced.

Retinopathy. Lipotriad capsules, 3 t.i.d. for several months may improve the condition.

After Treatment. When the diet and the necessary insulin dosage are determined, the patient can begin to look after himself, with monthly tests by the doctor of the blood and urine. He should be instructed how to give the insulin, how to test the urine morning and evening, and to keep the syringe with needle attached in industrial spirit in a long spirit-proof container; he should also be warned of the danger of hypoglycæmia, that he must always have a carbohydrate-containing meal within half an hour of a dose of insulin, that he should not take violent exercise while he is having injections, that he should carry sugar with him to eat, should early symptoms of hypoglycæmia occur. With a feverish cold he will temporarily require more insulin. He must always guard against constipation. He may also be given a table showing how his standard diet can be varied.

Treatment of Coma

Coma Due to Ketosis. The following routine should be observed: The patient should be admitted to hospital if possible. The bed should be warmed with an electric blanket or hot bottles, great care being taken to avoid burning the patient. The lungs should be examined to exclude pneumonia, and, if present, a course of penicillin injections begun. A catheter specimen of urine is taken and tested for glucose and ketone bodies. A specimen of blood is sent to the laboratory for blood sugar, urea and alkali reserve estimations. The blood pressure is taken. If the urine contains much sugar give an immediate injection of 100 units of soluble insulin subcutaneously, and if the pulse is very feeble 20 units also intravenously. There is usually considerable dehydration owing to the polyuria and possibly to the vomiting in the early stages. Five litres or more of fluid may be lost from the blood and tissue spaces, the greater part being from the latter site. To combat dehydration give an intravenous injection of 1,500 ml. of normal saline in 1 hour and later run it in at the rate of 500 ml. an hour, up to a total of 4 to 5 litres in 24 hours. If there is evidence of cardiac failure the saline must be run in more slowly, taking care that œdema of the lungs does not develop. Alternatively a solution of sod. chlorid. 5.85 G., sod. lact. 8.36 G., aq. dest. ad 1,000 ml. may be used. The stomach should be washed out and an enema given providing the patient is not too collapsed. The blood sugar reading should now be available, but if this is not possible subsequent insulin injections must be guided by the sugar content of the urine. Some authorities advise injecting 100 to 200 units of insulin every hour at first, but usually good results are obtained with 50 units every hour. The mistake which is liable to be made is not to give enough insulin. In very severe cases larger amounts are required, up to 1,000 units in the first 24 hours. As soon as ketone bodies disappear from the urine smaller amounts of insulin are required. It is a moot point whether or not dextrose should be injected intravenously. By so doing ketosis is likely to disappear more rapidly, and it also avoids the possibility of converting the hyperglycæmia into hypoglycæmia. It is usually helpful to replace the normal saline drip by one containing 5% dextrose in one-third

normal saline after the first 2 to 3 litres have been infused, running it in at 500 ml. an hour. This also usually increases the urine output and aids in raising the blood pressure. If the pressure remains low 500 ml. of whole blood should be given intravenously. In addition nikethamide (Coramine) 2 to 6 ml. may be injected into a vein. If the urine shows no glucose at any test no further insulin should be given until a blood sugar reading has been obtained. In some cases after the ketosis has disappeared the blood potassium falls to a low level with extreme weakness of the limb muscles and of the diaphragm, resulting in dyspnoea. For this 2 G. of potassium chloride may be given every hour for 3 doses, if the patient can swallow, or 200 ml. of a 1% solution of potassium chloride are run slowly into a vein. Potassium salts should not be given if there is oliguria.

On recovery from coma the patient should be given milk, 6 to 8 fl. oz. (180 to 240 ml.), every 3 hours, with water, meat extracts or orange juice, between the milk feeds, and insulin 8 times a day in amounts sufficient to keep the urine nearly free from sugar; acetone bodies will reappear, and to get rid of them dextrose should be given in addition, $\frac{1}{2}$ to 1 oz. (15 to 30 G.) in the three feeds which follow the insulin injections. In about 24 to 48 hours the patient can be put on a diabetic diet and the extra dextrose continued until the acetone bodies disappear from the urine, the insulin being adjusted to keep the urine sugar free. A careful search for a septic focus should now be made, and if possible it should be eradicated. One million units (600 mg.) of benzylpenicillin should be injected daily for 5 days as a prophylactic against infection.

Coma Due to Hypoglycaemia. Hypoglycaemic coma may come on suddenly, the patient having convulsions. It may occur during the night while the patient is asleep. The patient who is receiving insulin should always have with him some lumps of sugar and eat them at the earliest symptom. Hypoglycaemic coma can usually be relieved by the intramuscular injection of 1 ml. of inject. adrenaline (B.P.) 1 in 1,000 and the intravenous injection of 20 to 100 ml. of 10% dextrose in normal saline, which should be repeated every half hour if necessary. In some cases as much as 200 G. of dextrose are required. Alternatively, if the coma is not very deep, dextrose 2 oz. (60 G.) in water 6 fl. oz. (180 ml.) may be introduced into the stomach through a nasal tube. When the patient can swallow he should be given dextrose $\frac{1}{2}$ oz. (15 G.) by mouth every hour for several hours, especially if the hypoglycaemia is due to a long-acting insulin.

Crystalline glucagon may also be used for insulin shock, 0.2 mg./kg. body weight being injected intravenously.

Pre-Diabetes

It is estimated that there were about 300,000 diabetics in England and Wales under treatment in 1962, and an equal number not detected.

Screen surveys, testing urine with the Clinistix, give some idea of the incidence of disturbances of glucose metabolism. These have led to a classification of (a) diabetes, (b) intermediate (pre-diabetes or potential diabetes) and (c) non-diabetes.

Pre-diabetes has been defined as "the period in life of a diabetic before the diagnosis is made." The effective secreting power of the pancreas may be slightly reduced. The oral dextrose tolerance test may show slight abnormalities under the usual test conditions, but the augmented prednisone dextrose tolerance test may be abnormal. The patient is given 20 mg. prednisone at noon, 4 pm. and 8 pm. while taking a high carbohydrate diet. If the test is abnormal, the glucose in all the urine passed between 10 pm. and 6 am. is increased, the upper normal limit being 60 mg./hour.

The intravenous test is more accurate than the oral test, owing to differences in dextrose absorption in the latter.

Subjects likely to be in a pre-diabetic state are women who have large babies or still-births, and anyone who has a family history of diabetes.

There is no certainty that a pre-diabetic condition will develop into diabetes, and there is no known method of preventing a pre-diabetic condition from becoming diabetes.

Acidosis

Acidosis implies that there is a lowering of the alkali reserve (chiefly bicarbonates) in the blood. There is not necessarily an acidemia, *i.e.*, increase in the hydrogen ion concentration of the blood. In ketosis, such abnormal substances as β hydroxybutyric acid and acetone are present in the blood.

Clinical Findings. Acidosis is of importance in several conditions such as : Diabetes, this is described on p. 668. Unexplained pyrexia in children, and recurrent cyclic vomiting may be due to acidosis ; such children are abnormally intolerant of fat in their diet or of fat-containing medicines such as cod-liver oil. Von Gierke's disease is accompanied by acidosis. Acidosis may occur in renal failure owing to diminished formation of hydrogen and ammonia ions, and reduced urine output. Severe starvation or chronic diarrhoea lead to acidosis. Carbon monoxide poisoning causes acidosis by interference with the oxygen supply of the tissues. In acute necrosis of the liver and in pernicious vomiting of pregnancy, acidosis may occur, probably due to the toxic effects on the liver. Acidosis also results from the administration of ammonium chloride. The symptoms vary to a certain degree with the predisposing causes ; they include headache, faintness, nausea, vomiting, abdominal pain, air hunger, neuritis and pyrexia.

Differential Diagnosis. This is effected by : 1. Examination of the urine for acetone bodies. 2. Determination of the alkali reserve of the blood. 3. Determination of the alveolar CO_2 tension.

Treatment. Prophylactic. Acidosis can be prevented by ensuring a sufficiency of carbohydrate in the diet, together with insulin, if required in diabetes, to metabolise the carbohydrate.

Curative. Dextrose must be given by mouth, 1 to 2 oz. (20 to 60 G.) daily, or by rectum or intravenously, so that the glycogen content of the liver is maintained. Dehydration and ~~acidosis~~ acidosis should be corrected by the intravenous injection of normal NaCl of a mixture of isotonic sodium chloride and of isotonic sodium

Alkalosis

Alkalosis is characterised by an increase in the available alkali reserves in the blood. In alkalæmia the hydrogen ion concentration is lowered.

Clinical Findings. Alkalosis results from administration of massive doses of alkali, as in the treatment of gastric or duodenal ulcers, especially if there is gastric stasis or renal insufficiency. It may also be caused by persistent vomiting, due to obstruction at the pylorus or high up in the intestine. In hyperventilation and in anoxæmia associated with high altitudes or heart failure there is alkalæmia with a fall in the alkali reserves. The chief symptoms are: Malaise, headache, giddiness, anorexia, vomiting, tetany and coma.

Differential Diagnosis. This can be confirmed by determining the alkali reserve of the blood, and the blood nitrogen figures are usually raised.

Treatment. All alkalis should be discontinued at once, and 1 oz. (30 G.) of dextrose given by mouth 3 times a day. Normal saline should be injected intravenously. In severe cases the electrolytic balance must be restored by the intravenous injection of a solution of potassium, sodium and ammonium chloride.

Gout

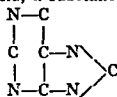
Definition. A disease characterised by excess of uric acid in the blood, uratic deposits in tissues, and joint manifestations. Podagra implies gout in the foot and cheiragra gout in the hand.

Etiology. The cause is not known. There is probably a metabolic error with regard to nucleoproteins, combined with a sensitiveness to certain protein substances, such as are contained in foods or bacteria, which precipitate an attack. Gout is often associated with asthma, urticaria or eczema. Gout is not due solely to excess of uric acid in the blood, as much higher figures are obtained in such diseases as leukæmia, without any manifestation of gout. *Predisposing causes:* 1. Heredity: The gouty diathesis is frequently noted in Europe, and it is said that in America out of 7 million sufferers from chronic rheumatism, one-third of a million are affected by gout. 2. Age: Usually middle age and after. 3. Sex: Males predominate. 4. Food and alcohol: Overeating, especially of meat, and overdrinking, especially of beer, port and sweet wines. 5. Occupation: Workers in lead and maltsters are prone to gout. 6. Infection: In teeth, tonsils, nasopharynx and the intestinal tract. 7. Season: Especially in the spring. 8. Locality: Chiefly in temperate zones, especially England and Germany; gout is rare in Scotland, probably due to a low incidence of beer and wine drinking. An attack may be precipitated by trauma to a joint, by a surgical operation, by injection of crude liver preparations, by mental worries, by certain articles of diet which vary in different individuals, such as strawberries, white wine, port, etc., by infection with micro-organisms and by chlorothiazide and its derivatives. Gout is much less common nowadays,

presumably due to moderation in food and drink and the greater attention given to the eradication of septic foci.

Pathology. There is an excess of uric acid in the blood, the average amount in gout being 5 to 9 mg. per 100 ml. (normal 1 to 4 mg. per 100 ml. plasma.) Deposits of mono-sodium urate are found in tissues which are comparatively avascular and rich in sodium. Thus tophi ("chalk stones," composed mainly of urates) occur in the cartilage of the ear, eyelid, nose, in the olecranon and prepatellar bursæ, around joints especially of the hands and feet and in tendons and ligaments. The uric acid elimination in the urine is diminished for a day or so before an acute attack of gout, but increases during the attack. Uric acid is derived from nucleoprotein; nucleoprotein is present in the cell nuclei of the tissues (endogenous source) and in the nuclei of foodstuffs (exogenous source). It may also be synthesised to a slight degree in the body from glycine, serine, ammonia and carbon dioxide. Nucleoproteins in the body are metabolised with the formation of nucleic acid, a substance containing the purin ring, C_5N_4 . This is converted into adenine (amino-purin) and guanine (diamino-purin), and by an enzyme, xanthine oxidase, a flavoprotein, into hypoxanthine (oxypurin), xanthine (dioxypurin) and finally into uric acid (trioxypurin). It is probable that all the uric acid formed in man is not excreted, some being further katabolised in the blood.

PURIN
RING.



Post-mortem examination of an affected joint shows whitish smears of urate on the cartilage, just under the surface; the palms of the hands may show white lines; the joints are deformed; tophi may be seen ulcerating through the skin. Death usually results from complications due to cardio-vascular degeneration or chronic nephritis. Thus myocardial degeneration, pericarditis, atheroma, arteriosclerosis, cerebral hæmorrhage, chronic nephritis or bronchitis may be found. Uratic deposits may be seen at the apex of the pyramids of the kidneys.

Clinical Findings. Acute Gout. The patient is usually a middle-aged man, who may give a history of previous attacks or of digestive troubles. For a few days before the attack he feels irritable, depressed and may have flatulent dyspepsia and constipation. The attack usually begins during the night, the patient waking with severe pain of a burning, boring character in the metatarso-phalangeal joint of the big toe, in the ankle or heel; he may shiver and sweat, and after several hours' agony fall asleep to awake in the morning and find the joint swollen, red, hot, tense and shiny. Post-operative gout is described appearing from a few hours to a few days after a surgical operation.

or it may begin at night and last through the day. After the attack the patient often feels extremely fit. Other joints less frequently affected are those of the finger or thumb, the knee, wrist or elbow, but very rarely the hip or shoulder. Polyarthritic attacks are infrequent. The blood : During an attack this shows a polymorphonuclear leucocytosis of 20,000 to 25,000 per c.mm. The sedimentation rate of the red cells is considerably increased during the acute stage. The urine : Uric acid excretion falls before, and rises during the attack for 2 or 3 days.

Differential Diagnosis. Acute gout must be distinguished from acute rheumatism, suppuration around or in a joint, gonorrheal arthritis, infective arthritis, synovitis, an inflamed bunion, and tuberculous or syphilitic arthritis. The characteristics of acute gout are the typical appearances and history, the presence of tophi in the ears, etc., and a blood uric acid content of over 4 mg. per 100 ml.

Pseudogout may be mistaken for gout. The arthritis is caused by crystals of calcium pyrophosphate. The attacks may appear to be typical of gout, but larger joints are particularly affected, especially the knees. X-rays show calcification in the joint. The uric acid level in the blood is normal. Diagnosis is established by finding calcium microcrystals in the synovial fluid.

Course and Complications. A second attack may never occur, but usually it develops within a year, subsequent recurrences are more frequent. Complications include suppuration around tophi; cardiovascular degeneration and chronic nephritis are often met with.

Prognosis. Gout is seldom fatal, unless associated diseases are present. Death is usually due to cardio-vascular or renal lesions.

Treatment. Prophylactic. When there is gout in the family, the precautions required are the eradication of all septic foci and moderation in eating and drinking. If the patient recognises the premonitory symptoms of an attack, he should take tab. colchicine 1/240 gr. (0.25 mg.) 2 tabs. two-hourly for 4 to 6 doses.

Curative. During the attack : The leg or arm should be supported on a pillow, covered with wool and guarded by a cradle. Warm fomentations of lotio plumbi c. opio (B.P.C.) diluted with an equal volume of water on lint, or of Sod. bicarb. 1 oz. (30 G.), tnc. opii 1 fl. oz. (30 ml.) and water to a pint (600 ml.) may be applied. The bowels should be opened by a saline aperient. At the first symptom colchicine should be taken in the doses recommended above every 2 hours when awake. It should be continued until the pain is relieved or until diarrhoea occurs. In no case should more than 8 mg. be given in a course. In a subsequent acute attack the patient should take 2 tablets of colchicine less than the dose which produced diarrhoea. Good results have been obtained by the intramuscular injection of ACTH (Cortrophin-ZN) 60 to 80 i.u. followed by a similar dose 24 to 48 hours later if necessary. Prednisone also has a good effect in doses of 20 mg. b.i.d. for 3 or 4 days, and then 10 mg. b.i.d. daily for 4 to 8 days. Colchicine should be given simultaneously in small doses, 1 tab. 1/240 gr. (0.25 mg.) twice a day, providing there is no diarrhoea, and continued for a few days after discontinuing the ACTH or prednisone. Phenylbutazone (Butazolidin)

is also effective in gout, in doses of one tab., 100 mg., every 6 hours for 4 doses, then every 8 hours for 3 doses, and then twice daily until the attack subsides. The patient should drink plenty of fluids, 4 to 8 pints (2.4 to 4.8 litres) in the 24 hours, hot water, hot weak tea, orangeade, or barley water, and he may also have toast, milk, bread and butter, and milk pudding. After the acute symptoms have subsided the diet is increased, fish and chicken being given. Atophan (cincophenum B.P.) is a dangerous drug, it may cause acute necrosis of the liver and should not be prescribed. All infective foci in the mouth should subsequently be eradicated.

Chronic Gout. Gout is considered to be chronic when an attack lasts for several weeks, or when attacks recur at short intervals. Usually several joints are affected, permanent deformity ensues and the general health is impaired. The tophi may ulcerate through the skin and suppuration occur around them. There may be thickening of the olecranon and prepatellar bursæ. The urine may contain a trace of protein or of glucose. Eczema is often present. The tophi usually differentiate chronic gout from osteoarthritis, although the two conditions may be combined. X-ray examination of the hands may show "punched out" areas in the distal parts of the phalanges. Fibrositis is sometimes a manifestation of chronic gout.

Treatment. **Diet.** The patient should avoid substances rich in purins, such as sweetbreads, liver, kidneys, brains, sardines, anchovies, turkey, pork, veal, beef, duck, goose, partridge, bacon, rabbit, lamb, meat soups and extracts, and lentils. Purin-poor substances are advisable, these include white bread, butter, cheese, eggs, rice, tapioca, milk, cereals, and green vegetables. Fruits, such as peaches, apples, pears, grapes, cherries, and oranges may be given. As the blood uric acid rises on a high fat diet, the amount of fat taken should be strictly limited. Carbohydrates do not appear to be harmful. Plenty of fluid, such as hot water, should be drunk on rising and retiring. Tea, coffee and cocoa may be taken in moderation. It is better to avoid all alcohol. A little "dry" wine or whisky may be allowed. The bowels should be kept open regularly and a saline aperient taken from time to time. The continuous use of uricosuric drugs to prevent recurrent attacks of gout and to provoke resolution of tophi is now generally recognised. The choice lies between probenecid (Benemid), Anturan, salicylates and allopurinol (Zyloric). Benemid is put up in 0.5 G. tablets. Treatment is begun with 1 tab. daily, then 2 tabs. daily, and then 3 or 4 tabs. daily. The maintenance dose is 1 to 4 tabs. daily, according to the blood uric acid level. Benemid causes a rapid fall in the blood uric acid level from 10 mg./100 ml. to a level of 4 mg./100 ml. After the patient has been taking the tablets for a few weeks he may develop an attack of gout, the so-called "Benemid gout." This may be prevented by the simultaneous administration of tab. colchicine 1/240 gr. (0.25 mg.), 2 tabs. daily for 2 weeks.

Anturan is put up in 100 mg. tabs., the maintenance dose being about 2 tabs. daily. Sodium salicylate 90 gr. (6 G.), is given in divided doses, daily for 6 months, when the dose can be reduced to three times a week.

Allopurinol, in doses of 200 to 400 mg., is an alternative to uricosuric drugs when renal function is impaired or when other drugs are ineffective. It diminishes uric acid formation by inhibiting the oxidation of hypoxanthine and xanthine into uric acid. It is put up in scored tablets of 100 mg. Colchicine, in doses recommended above, should be given during the initial period to prevent the precipitation of an acute attack of gout. Its use later may be combined with that of salicylates.

Irregular Gout. (Suppressed or retrocedent gout.) In some cases an acute attack of gout ceases suddenly, as may happen if the affected part is put into cold water. The patient may become unconscious or die. Death is probably not due to gout but to associated degeneration in other organs, such as the cardio-vascular or renal system. It is thought that in some cases gout may give rise to acute gastric or intestinal symptoms, to præcordial pain unrelated to effort, and that ocular lesions, such as iritis, conjunctivitis and choroiditis, may, in some cases, be due to gout rather than to infection.

Obesity

(*Lipomatosiſ Universalis*)

Definition. Excessive generalised deposition of fat in the body.

Physiology and Pathology. The nature of the regulating mechanism which controls body weight is not known. The diet of an average healthy male not doing heavy muscular work is composed of about 500 G. of carbohydrate, 100 G. of protein and 100 G. of fat, and yields 3,800 calories. In order to maintain a steady weight the energy output must balance this intake. The energy expended is made up of basal metabolism, metabolism due to muscular activity, and possibly metabolism resulting from the specific dynamic action of food. As a diet of 3,800 calories yields more energy than is necessary for physiological requirements, the metabolic processes are presumably raised in individuals who do not put on weight or else a considerable amount of the food is excreted undigested. There is no evidence to support the latter view. Obesity may be :—

1. **Developmental.** This is usually a hereditary condition.
2. **Nutritional or exogenous.** This may be due to overeating, overdrinking, alcoholism, and lack of exercise. In some cases there is water retention in the tissues, especially in the fatty tissues. Giving up smoking usually results in a gain in weight, as the patient eats more. Worry and other psychological factors may also result in obesity.
3. **Metabolic or endogenous.** This may result from endocrine disturbances, such as hypothyroidism, hypothalamic lesions, hyperadrenia associated with Cushing's syndrome, hyperadreno-corticalism and deficiency of secretion from the ovaries (as at the climacteric) or from the testicles (as in eunuchs). It has been suggested by Kekwick *et al.* that obese people may be able to turn fat into carbohydrate at a higher rate than the non-obese.

Clinical Findings. The weight of the patient is usually several stones (1 stone = 6.5 kg.) above the normal for the age and height, the

disposition is generally calm and cheerful, the only complaint being due to the personal appearance and discomfort of the excess of fat, which may also cause dyspnoea from cardiac embarrassment. Investigation of cases of obesity involves first an inquiry into the history as regards heredity, diet and exercise. An estimation should be made of the basal metabolic rate, sugar tolerance and water elimination, and special tests performed with respect to the ductless glands. Unless the obesity is due to hypothyroidism, the basal metabolic rate is usually within normal limits.

Course and Complications. The condition is often slowly progressive, and complications may occur, such as flat feet, arthritis of the knees, hypertension, fatty infiltration or degeneration of the heart, diabetes mellitus and chronic bronchitis.

Prognosis. Obesity tends to lower the expectation of life, owing to the liability to complications; further, severe illnesses and abdominal operations are less well borne.

Treatment. Prophylactic. Where a hereditary tendency exists, a regular check should be kept on the weight. Any increase should at once be countered by a dietetic restriction or increase in exercise. As a man weighing 70 kg. will only use up 140 calories on walking 2½ miles (4 km.) in an hour, it can be seen that reduction of diet is of greater importance than an increase of exercise in keeping the weight within bounds.

Curative. It is usually difficult to persuade the patient that the only source of his excessive fat is what he puts in his mouth. In developed cases of exogenous obesity the weight should be gradually reduced by about 2 to 3 pounds (0.9 to 1.4 kg.) a week. The caloric value of the patient's normal diet should first be determined; it will often be found to be high, over 4,000 calories. Sugar, potatoes, cakes, sweets, chocolate, butter, jam, marmalade, honey, puddings, pastries, ices, sausages, nuts, cheese, wines and beer should then be eliminated and bread reduced. Weight is sometimes lost more quickly if the patient is kept in bed for a week or two at the beginning of the treatment. If this does not produce sufficient loss in weight the patient should be placed on a special diet containing about 1,000 calories. It should contain about 1 G. of protein per kg. of body weight, and not too much fat or severe acidosis is liable to develop. The following diet of about 1,000 calories, containing approximately protein 80 G., fat 38 G., and carbohydrate 77 G. may be used. About 75 G. carbohydrate is necessary daily for brain metabolism.

Breakfast. Grilled fish, 4 oz. (120 G.), or grilled fish, 2½ oz. (75 G.) and egg (1), or bacon, ½ oz. (20 G.) and tomatoes, 3 oz. (90 G.), or cold ham, 2 oz. (60 G.), or bacon, ½ oz. (15 G.) and egg (1), or eggs (2), boiled or poached; Toast, ½ oz. (15 G.); Butter, ½ oz. (5 G.); Sugarless marmalade, ½ oz. (15 G.); Milk, 1½ fl. oz. (45 ml.); Tea. **Lunch.** Roast beef or mutton, hot or cold, 2 oz. (60 G.), or grilled steak, boiled beef, grilled chop, boiled mutton, roast turkey or chicken, 2½ oz. (75 G.), or veal, 3 oz. (90 G.), or grilled sweetbreads, 3 oz. (90 G.) with bacon, ½ oz. (15 G.), or liver, 3½ oz. (105 G.); Green vegetables, 4 oz. (120 G.) or salad, 4 oz. (120 G.); Stewed fruit, 3 oz. (90 G.) or fresh

fruit, 4 oz. (120 G.); Toast, $\frac{1}{2}$ oz. (15 G.); Butter, $\frac{1}{8}$ oz. (5 G.). Dinner. Fried fish, 2 $\frac{1}{2}$ oz. (75 G.) or meats as at lunch, or eggs (2) boiled, poached or made into an omelette; Vegetables, fruit, toast and butter as at lunch; Toast may be increased to 1 oz. (30 G.) if the vegetables are omitted; Tea. 10 p.m. Water biscuits (2); Milk, 1 fl. oz. (30 ml.); Tea; Saccharin for sweetening at all meals.

Fluid should be restricted to about 50 fl. oz. (1.5 litres) in the 24 hours. Appetite may be reduced by taking dexamphetamine sulphate, 10 mg. tab. or Preludin (phenmetrazine) tab. 25 mg. half an hour before breakfast and lunch. In obesity due to hypothyroidism, thyroideum $\frac{1}{2}$ to 1 gr. (30 to 60 mg.) or tab. thyroxine sodium B.P. 0.05 mg. tab. to 0.1 mg. tab. can be given daily and gradually increased.

Mersalyl or chlorothiazide derivatives (see p. 243), a salt poor diet and restriction of fluid intake to 35 or 40 fl. oz. (1 or 1.2 litre) in the 24 hours should be used for excess of weight due to water retention. Exercise should also be taken, a walk of a mile or more daily or simple exercises such as contracting the trunk and abdominal muscles.

Localised Lipomatosis

Localised deposits of fat may occur in the following conditions:—
1. Lipoma, single or multiple. These should be removed if growing rapidly owing to the risk of sarcomatous changes. 2. Localised obesity, the fat accumulating over the hips or abdomen. Vibration and massage are useful in these cases. Gluteal humps of fat are met with in Bushmen and Hottentots. They are analagous to the camel's hump and become flabby during starvation. The condition is known as *steatopygy*. Symmetrical excess of adipose tissue may form in the neck, constituting the "fat neck" of Madelung. 3. Adiposis dolorosa. 4. Pseudo-hypertrophic muscular dystrophy.

Lipodystrophia Progressiva

A disease of children characterised by progressive wasting of the face, neck, arms, thorax and abdomen. The cause is not known, it has been suggested that it is due to a tropho-neurosis. The buttocks and legs are usually normal but in women there may be increase of fat over the hips, buttocks and legs. The wasting is due to loss of fat, the tone of the muscles being normal. The loss of fat is steadily progressive for periods up to 2 or 10 years. The general health is not impaired.

Localised Lipodystrophy

Loss of subcutaneous fat occurs in some individuals in the arms or legs, in association with repeated injections of insulin (see p. 670). Local panatropy may also occur apart from insulin injections, with wasting of the subcutaneous tissues including muscles. It may be seen in the arm or leg and the cause is unknown.

Ochronosis

Definition. A rare disease characterised by pigmentation of cartilage and skin, arthritis and urinary changes.

Etiology. There are three groups of cases : 1. Associated with alkaptonuria, an inborn error of metabolism of tyrosine and phenylalanine, in which, owing to a complete lack of homogentisic acid oxidase, homogentisic acid is excreted in the urine. 2. Associated with chronic absorption of carbolic acid, used for dressing wounds, usually ulcers on the legs, for prolonged periods, such as 20 or 30 years. Carboluria is usually present. The steps in the conversion of phenol to ochronotic pigment are not known. 3. Occurring apart from either of these conditions.

Pathology. In ochronosis melanin is deposited as yellow-brown particles in the cartilage of the ears, nose, eyelids, trachea, bronchi and in the ligaments and fibrous tissues of the body. Chronic osteoarthritis may be present in the large joints. In alkaptonuria, homogentisic acid is passed in the urine, owing to incomplete metabolism of tyrosine.

Clinical Findings. The patient is usually an adult who seeks advice either on account of the pigmentation of the ears or face, or because of arthritis. A child may be brought to the doctor because his urine darkens on standing, or the patient may seek advice because he has been rejected for life assurance. In the cases due to carboluria a history is usually obtained of a wound being treated with carbolic dressings for a prolonged period.

On Examination : The cartilaginous parts of the ears appear bluish, and a blue-black area of pigmentation may be seen in the sclerotics. The tendons of the hands are pigmented and the skin of the face and hands may be yellow-brown or brownish-black in patches. Osteoarthritis may be found in the knees or other joints. X-ray examination may show calcification of the intervertebral discs. The urine may contain homogentisic acid, becoming dark on standing, staining the clothes and reducing Benedict's and Fehling's solutions, or it may give the reaction for carboluria.

Differential Diagnosis. Alkaptonuria must be differentiated from glycosuria by chemical tests. *Yeast does not ferment homogentisic acid.*

Course and Complications. Alkaptonuria is a congenital abnormality and persists through life.

Prognosis. Alkaptonuria does not shorten life.

Treatment. *Prophylactic.* Carbolic acid should not be used for dressings for prolonged periods.

Curative. If the ochronosis is due to carbolic acid, the dressings must be discontinued ; in alkaptonuria the protein in the diet should not exceed 100 G. a day.

Hæmochromatosis

(Diabète Bronzé)

Definition. A disease characterised by pigmentation of the skin, fibrosis of the liver and pancreas, and glycosuria.

Etiology. Hæmochromatosis is probably due to an inborn error of iron metabolism. Males predominate over females in the proportion of 20 to 1. It is probably inherited as an autosomal recessive gene. The fundamental abnormality appears to be an increased absorption of iron,

possibly due to the greater reducing power of the intestinal reducing cells which form more ferrous iron than normal. The lower incidence in women is probably due to blood losses at menstruation and pregnancy, which get rid of excessive iron in the blood. It has been suggested that wine may be the source of iron in chronic alcoholics who develop hæmochromatosis. Transfusion hæmochromatosis, occurring after over 100 transfusions for aplastic anæmia, has been described, and also dietary hæmochromatosis in which there is increased absorption of iron.

Pathology. Hæmosiderin is deposited in excess in nearly all the tissues, including the skin. Hæmofuscin (iron-free), which is related to melanin and contains sulphur, is deposited in the heart and intestinal muscle. The liver may contain up to 50 G. iron. This does not result from increased blood destruction, but is probably due to increased absorption of iron, the "mucosal block", which normally limits the absorption of iron, not being efficacious. The liver, pancreas and spleen are cirrhotic and the glycosuria is considered to be secondary to chronic interstitial pancreatitis.

Clinical Findings. The patient is almost invariably an adult over the age of 40 who notices darkening of his skin, or else complains of the symptoms of diabetes, such as thirst, polyuria and loss of weight, or of those due to chronic acidosis, such as headache and neuritis. The late age of onset is due to the gradual accumulation of iron in the tissues.

On Examination: The body is somewhat wasted, the skin shows excess of pigmentation, especially in the face, axillæ and groins, and pigment may be deposited in the mouth, but there is no jaundice. The pigmentation may be ashy-grey, slaty-blue due to iron, or bronze due to melanin. In some cases cutaneous pigmentation is absent. The liver is enlarged, firm and irregular, and the spleen may be felt. There is sexual hypoplasia with loss of pubic and axillary hair. The urine in about 80% of cases contains glucose and acetone bodies may be present. Hæmosiderin may be found in the urinary deposit. A blood sugar tolerance test shows the typical diabetic curve when glycosuria is present. In the early stages there may be no glycosuria, and in some cases there is no cutaneous pigmentation. The serum iron level is raised, above the normal of 80 to 180 micrograms per 100 ml.

Differential Diagnosis. Other causes of pigmentation must be excluded, such as Addison's disease. The presence of iron in the skin and sweat glands is diagnostic of hæmochromatosis. The hepatic enlargement should be differentiated from cirrhosis due to other causes or to carcinoma. Needle biopsy will establish the diagnosis. The association of pigmentation, enlarged liver, glycosuria, and heart failure is very suggestive.

Course and Complications. The course is usually slowly progressive. Ascites may develop. Other complications include rupture of œsophageal varices, pulmonary tuberculosis and diabetic coma.

Prognosis. This is rather more unfavourable than in the case of diabetes mellitus. Death may occur from diabetes, from cardiac failure, from cirrhosis of the liver, or from hepatoma.

Treatment. When glycosuria is present the treatment is similar to

that employed in diabetes mellitus. Repeated venesections have been suggested, such as 500 ml. every week. These will remove about 250 mg. iron from the blood, and a corresponding amount passes from the tissues into the blood. The results of venesection as a long term treatment have not yet been determined.

Primary Amyloidosis

The cause of this rare condition is unknown. This group includes the inherited amyloidoses. The tissues in which amyloid is deposited include the heart, the skeletal and smooth muscles, lymph nodes, the tongue, the arteries and the skin. The spleen, liver, kidneys and adrenals are less often involved. The tongue is enlarged; papules, plaques and localised hæmorrhages may be seen in the skin and mucous membranes. The disease is met with after the age of 40 years, the clinical picture being usually that of congestive heart failure or bilateral pleural effusion, with, at times, peripheral neuropathy. The latter is characterised by lightning pains and muscle weakness. The peripheral nerves may be thickened. There may be difficulty in speech and in swallowing. Biopsy of the tongue or of a skin lesion may establish the diagnosis, but the congo-red test for amyloid is unreliable. Death usually occurs from heart failure in about 3 years from the date of diagnosis.

The Fanconi Syndrome

In this disease there is a complicated assortment of metabolic errors due to a congenital defect in the renal tubules which affects both their secretory and re-absorptive functions. As a result of a defect in the proximal convoluted tubules there is excessive loss in the urine of glucose, phosphate, calcium, bicarbonate, amino-acids, acetoacetic acid, potassium and ammonia. The continuous hypophosphatæmia results in rickets in children and in osteomalacia in adults.

Renal tubular acidosis, also known as Albright's syndrome, resembles clinically the Fanconi syndrome, but it is less severe. There is not, however, renal glycosuria and no loss of amino-acids in the urine.

Treatment. Sodium bicarbonate should be given by mouth to restore the electrolytic balance, and, for the softening of bones, calcium and vitamin D, as in the treatment of rickets.

Hartnup Disease

This is a disease of disordered amino-acid transport across the mucous membrane of the jejunum and the renal tubule. There may also be an error in the conversion of tryptophan to nicotinic acid.

The disease is characterised by a pellagra-like skin rash, with temporary cerebellar ataxia, constant renal amino-aciduria and other bizarre biochemical features.

Phenylketonuria

This is an inborn error of metabolism characterised by inability to convert phenylalanine to tyrosine, owing to the absence of the hydroxylase enzyme from the liver. The accumulation of phenylalanine in

the body results in mental deficiency or idiocy. Phenylketonuria can be diagnosed by detecting phenylpyruvic acid in the urine. This gives a green-blue colour when a few drops of a 5% solution of ferric chloride are added to the urine, or placed on the infant's napkin which is wet with urine. Alternatively, a "Phenistix" strip may be dipped in the urine. In the presence of phenylpyruvic acid it turns green. Every infant's urine should be tested at the age of 8 weeks and again at 8 months.

Treatment. This consists in giving a low phenylalanine diet before intelligence has seriously deteriorated. An adequate amount of protein is obtained by the use of a casein hydrolysate of low phenylalanine content to which other amino-acids are added. For infants Minafen should be used. This supplies 550 calories in 100 G. from the casein, amino-acids, carbohydrate and fat. Supplementary vitamins A, D and C should be given. Mixed feeding can be commenced between 4 and 5 months of age. For older children Cymogran should be used. Details of the diets are given in "Diets for Sick Children" (Hospital for Sick Children, Great Ormond Street, London).

"Maple Syrup Urine Disease"

(*Leucinosi*s)

This disease resembles clinically phenylketonuria, and there is severe mental deficiency. The metabolic defect is failure to metabolise valine, leucine and isoleucine, possibly owing to the absence of an enzyme, and the corresponding α -keto-acids are excreted in the urine, which smells like maple syrup.

Weber-Christian Disease

(*Relapsing Febrile Non-Suppurative Nodular Panniculitis*)

This disease is characterised by recurrent attacks of fever with the development of subcutaneous nodules, up to 12 cm. in diameter. The nodules are localised to the trunk and extremities, especially the thighs. There is a tendency for subcutaneous atrophy to occur at the site of the involuted nodules. The internal organs may also be affected, with fatty changes in the liver or pancreas. The fat in the abdomen may be infiltrated with plasma cells, lymphocytes and phagocytes. In some cases the skin over the underlying lesion becomes blue forming a bulla, this may rupture and discharge a yellow-brown sterile fluid rich in fat cells. The muscles may be involved causing severe weakness. There may also be muscle and joint pains. The cause is unknown. It may be a disturbance of lipid metabolism. It has been suggested that it is due to sensitisation to iodide, bromide, sulphonamide or penicillin, or that it is a bacterial allergy.

Treatment. In some cases a favourable response has been obtained with corticosteroids, or by oxyphenbutazone (Tanderil) 100 mg. tab., 2 tabs. t.i.d. reduced to 1 tab. daily.

Galactosæmia

This disease is transmitted by a simple autosomal recessive gene. There is an inability to utilise galactose. Lactose in milk is normally

split into galactose and glucose, and galactose is converted into glucose. The disease shows itself in the first 2 weeks of life, with such features as vomiting, diarrhoea, and, later, jaundice, hepatosplenomegaly, ascites and cataract may appear. In less severe cases there may be no early symptoms, but after several months mental and physical retardation may be apparent. The diagnosis may be made by finding galactose in the urine by paper chromatography, and by measurement of the deficient enzyme in the red cells.

The child should not be given milk and the diet should consist of eggs, sugar, margarine, and rice flour with vitamins and mineral supplements.

CHAPTER XIII

THE DUCTLESS GLANDS

THE THYROID GLAND

Introductory. The follicles (vesicles or alveoli) of the thyroid gland contain colloid, secreted by the lining cuboidal epithelium. The thyroid hormone, thyroxine, is present in the colloid, which is rich in iodine. Thyroxine has been obtained from the gland and also synthesised. One milligram of thyroxine is said to raise the B.M.R. of man by 3%. One grain (60 mg.) tab. of dry thyroid (thyroideum B.P.) is equivalent to 0.1 mg. tab. thyroxine sodium. Tablets of thyroideum B.P. may vary in their potency when prepared and are apt to become unreliable, especially if kept in a warm, moist atmosphere, or when exposed to light. Tablets of thyroxine sodium are probably uniformly potent when made, but, on storing, may also lose their potency, and so should have an expiry date. A daily intake of 0.16 mg. of iodine is sufficient to maintain the thyroid function. It is believed that thyroxine is formed from tyrosine combined with iodine. Iodine is liberated from iodides in the presence of peroxidase, manganese and oxygen. Iodine combines with tyrosine in the presence of a cytochrome enzyme to form first mono-iodotyrosine and then di-iodotyrosine. Di-iodotyrosine, by taking up two atoms of iodine, is converted in the presence of a cytochrome enzyme into thyroxine. This is stored in the thyroid as thyroglobulin. Thyroglobulin is acted on by a proteolytic enzyme and thyroxine is liberated. A substance which is about five times as active as thyroxine is also present in the circulation. It is tri-iodothyronine, and it differs from thyroxine in containing three, instead of four iodine atoms in its molecule. L-tri-iodothyronine sodium (liothyronine Tab. B.P., Terroxin) 5 micrograms and 20 micrograms tab. acts quickly, but is not suitable for maintenance treatment. Iodine exerts its antithyroid effect partly by inactivating the proteolytic enzyme, and partly by inactivating the thyrotrophic hormone of the anterior pituitary. Thiourea exerts its antithyroid effect by preventing the liberation of iodine from iodides and by interfering with the peroxidase system. Potassium perchlorate interferes with the iodide-trapping mechanism of the thyroid. The thyroid secretion is regulated by the thyrotrophic hormone (TSH) secreted by the anterior lobe of the pituitary. This hormone stimulates the thyroid to form thyroxine, but thyroxine inhibits the pituitary production of the thyrotrophic hormone. There is thus a balance between the activities of the pituitary and the thyroid. The thyrotrophic hormone, in addition, causes increased vascularity and hyperplasia of the thyroid, and in some cases exophthalmos. Thyrocalcitonin is thought to be a hormone produced by the thyroid which lowers the plasma calcium by causing deposition of calcium phosphate in bone. It may be of value in malignant bone disease to inhibit bone destruction, when there is hypercalcaemia.

Simple Goitre

(*Endemic and Sporadic Goitre. Diffuse Parenchymatous Goitre or Colloid Goitre. Nodular Goitre with Localised or Multiple Adenomata*)

Definition. General or local enlargement of the thyroid gland, without marked disturbance of thyroid function. The enlargement is neither due to inflammation nor to malignant disease.

Etiology. Goitre is produced by the thyrotrophic hormone of the pituitary. In endemic localities, where iodine is deficient in the water, babies are born with a goitre, due to a diffuse hyperplasia of the gland. Iodinated protein inhibits the production of the thyrotrophic hormone, so that if sufficient iodine is available the goitre is converted into a simple or colloid goitre. Certain substances are goitrogenic, thus rabbits fed on cabbage develop goitres. Other goitrogenic substances include foods of the Brassica family, soya beans, also thiourea and its derivatives, sulphonamides and thiocyanates. An epidemic of goitre occurred in Tasmania due to drinking milk from cows fed on a Brassica, marrow-stemmed kale. There are two main theories as to the etiology of colloid goitre: 1. Deficiency of iodine in the diet or the drinking water. 2. Impurity of the water due to organisms or suspended calcareous matter. Possibly in goitrous water there is something which prevents the utilisation of iodine, as endemic goitre has been eradicated in some districts by giving pure water free from all iodine or by adding iodine to the water. *Predisposing causes:* 1. *Locality:* Derbyshire and the Thames Valley in England, the Swiss Alps, Pyrenees, Maritime Alps, Himalayas, Rocky Mountains, etc. Air-borne iodine is present within three miles of the sea coast. 2. *Age:* Children and young adults. 3. *Sex:* Chiefly females and often associated with puberty, pregnancy and lactation.

Pathology. *Colloid Goitre.* The gland is uniformly enlarged. The vesicles are distended with colloid and lined with atrophied epithelium. The iodine content is increased.

Parenchymatous Goitre. The gland is uniformly enlarged. The vesicles contain less colloid than normal, and the epithelium tends to be columnar shaped. The iodine is diminished.

Nodular Goitre. Localised or diffuse adenomata may occur. The adenoma may develop from a foetal rest. The gland may be smaller than normal, with increased fibrous tissue. The adenoma may be solid or cystic, and hæmorrhages may be present in the gland. Pressure of the gland may flatten the trachea from side to side, producing a scabbard effect.

Clinical Findings. The patient is usually a young adult, who notices a swelling in the neck. There may be aching, a feeling of fullness or some dyspnoea. There is rarely dysphagia, but cough is not uncommon.

On Examination: With a colloid or parenchymatous goitre a diffuse swelling of the thyroid gland is found which moves with deglutition. It is not hard, but may become firm and irregular in long-standing cases, owing to fibrosis. In nodular goitre single or multiple localised swellings are found which are not very hard, and may be firm if enclosed in a fibrous capsule. A cystic adenoma feels more round and tense. In

some cases the enlargement is mainly retrosternal, and can then be diagnosed by X-rays, but the pressure signs may be obvious, such as enlargement of the cervical veins, stridor, hoarseness (pressure on the recurrent laryngeal nerve) and a small pupil (pressure on the cervical sympathetic). In about 60% of cases of colloid goitre there is evidence either of hyper- or hypothyroidism. In the former there may be tachycardia, nervousness, an increased basal metabolic rate and diminished sugar tolerance. In the latter there is a tendency to obesity, sluggishness, bradycardia, lowered basal metabolic rate and increased sugar tolerance.

Differential Diagnosis. There is usually little difficulty in recognising that the swelling is due to the thyroid gland. A diffuse swelling must be differentiated from that associated with Graves' disease, and a localised adenoma is distinguished from a toxic adenoma by the absence of severe symptoms of hyperthyroidism, and from a malignant tumour or Riedel's chronic thyroiditis by the absence of marked hardness.

Course and Complications. A simple goitre occurring at puberty or in connection with pregnancy often disappears in a few months. If definitely associated with a locality, the goitre usually persists throughout the patient's residence there, and, if fibrosis has occurred, it is usually permanent. An adenoma may undergo toxic changes, a hæmorrhage may occur into it, or it may become malignant.

Prognosis. This is favourable, and life is not usually shortened.

Treatment. Prophylactic. On the supposition that the cause is iodine deficiency, iodine may be added to drinking water in goitrous districts in the proportion of 1 lb. sod. iod. to 50,000 gallons water (1 kg. sod. iod. to 480,000 litres water) and iodised table salt used (1 part pot. iod. to 5,000 parts salt), or a course of sodium iodide can be given to school children in the spring and autumn 3 gr. (0.2 G.) daily for 10 days. This latter method has proved successful in America. Overdosage must be avoided owing to the danger of inducing thyrotoxicosis. A pure supply of drinking water or the use of boiled water in goitrous districts in India has also produced good results.

Curative. Small doses of iodine are beneficial although not always curative. If feasible, the basal metabolic rate should be determined and iodine given to those patients whose metabolism is subnormal or normal. Thus sodium iodide 1 gr. (60 mg.) may be given t.d.s., or liq. iodi simplex 4 to 10 drops t.d.s. in milk, or Lugol's iodine solution (liq. iodi aquosus B.P. Add.) 6 drops t.d.s. in milk. An operation is required to remove an adenoma causing pressure symptoms. It may also be performed in cases of disfigurement or to forestall the possibility of malignant changes. An adenoma should not be treated with iodine, as it may become toxic.

Hyperthyroidism

(*Thyrotoxicosis. Exophthalmic Goitre. Graves' Disease. Parry's Disease. Basedow's Disease. Flajani's Disease*)

Definition. A disease characterised by overactivity of the thyroid gland with sympathetic disturbances throughout the body.

Etiology. The cause is not known. Graves' disease is liable to follow infections, such as influenza, diphtheria, sinusitis, tonsillitis, etc. It may be associated with a nervous shock, but it was not common amongst soldiers in the 1914-18 or 1939-45 wars. In most cases of Graves' disease a long-acting thyroid stimulator (LATS) is present in the serum. It is not found in euthyroid patients. It does not originate in the pituitary, and its source is not known. The evidence indicates that it is a gamma-globulin, and that Graves' disease is caused by LATS and not by overproduction of TSH. LATS has a similar action on the thyroid, causing an overproduction of thyroxine. It is suggested that thyrotoxicosis is an autoimmune disease, LATS being an antibody resulting from an antigen produced in the thyroid. *Predisposing causes:* 1. Age: 15 to 40. Graves' disease has been seen in a newborn infant. 2. Sex: More common in females. 3. Absence of any previous goitre. 4. Locality. Districts free from endemic goitre. 5. Heredity. A thyrotoxic diathesis may be transmitted.

Pathology. The thyroid gland is enlarged and vascular, with increased fibrous tissue. There is an increase in the alveolar epithelium which may project in columnar-celled ridges nearly filling the lumen of the vesicles. The colloid is diminished and the iodine content of the gland low. Hyperplastic lymph nodes are constantly present in the gland. Adenomata or cysts may be present. Rienhoff has shown that after iodine treatment the vesicles contain more colloid, the lining epithelium becomes flat and the hyperplastic gland reverts to the resting colloid state. The thymus is often enlarged, and the cervical lymph nodes are enlarged. The cause of the ocular prominence is uncertain. It may be due to retro-orbital vascular dilatation, to lymphocytic infiltration, oedema, or fibrosis of the ocular muscles, or to the action of the pituitary thyrotrophic principle. There is no evidence that it is due to excess of retro-orbital fat, to stimulation of Müller's muscle, which is a vestigial structure in man, or to sympathetic stimulation. The pupil is not dilated in Graves' disease and exophthalmos may occur when the cervical sympathetic is paralysed due to long-standing syringomyelia.

Clinical Findings. The patient sometimes gives a history of a shock or intense worry, such as might arise from business or family connections and is followed by symptoms of nervousness, irritability and disturbed sleep. The onset may be quite sudden, the patient noticing that one or both eyes are prominent or that the neck suddenly swells. Other symptoms include loss of weight, lassitude, nervousness, palpitations, shortness of breath, moisture of the skin, especially on the palms of the hands, swelling of the ankles, and hair falling out. The patient usually feels worse in hot weather, the bowels may be relaxed and attacks of vomiting occur. Acute abdominal pain may simulate that produced by appendicitis. In some cases there are symptoms of diabetes insipidus, presumably due to pituitary disturbance. In the early stages there may be menorrhagia which is followed later by amenorrhoea. Oedema due to hypoproteinaemia may be the first symptom.

On Examination: The patient is usually rather thin and has a

characteristic startled appearance owing to prominence of the eyes. The skin is moist and may be flushed, especially on the face and over the neck and manubrium sterni. There may be pigmentation, especially on the face, arms and trunk, with leucodermic patches. Carotid pulsation is seen in the neck. Gynæcomastia may occur in males. The typical signs of Graves' disease are: 1. Enlargement of the thyroid gland. The gland is moderately soft and uniformly enlarged, and if the patient raises up the head while lying down the swelling largely disappears. Irregularities may be caused by a cyst or adenoma. A systolic murmur is heard over the lateral lobes of the gland. 2. Tachycardia. The pulse rate is usually over 120 when the patient is at rest. 3. Tremors. Fine tremors of the fingers are seen when the hands are held out. 4. Eye signs. These include exophthalmos, the prominence of the eyes being generally bilateral, rarely unilateral. Exophthalmos is present in about 95% of cases. Corneal ulceration may occur. *Von Graefe's sign*. When the patient looks down, there is lagging of the upper lid. *Stellwag's sign*. Blinking is infrequent. *Moebius's sign*. Lack of convergence of the eyes when the patient looks at an object which is brought near to him. *Jeffroy's sign*. When the patient looks up, the forehead is not wrinkled. *Dalrymple's sign*. Wideness of the palpebral fissure, due to retraction of the upper lid. The Merseburg triad of signs, described by Basedow in a patient living in Merseburg, consists of goitre, exophthalmos and tachycardia. The heart: The impulse is forcible and the apex may be displaced a little outwards and downwards. There may be irregularity due to premature systoles or atrial fibrillation with or without congestive heart failure. Blood pressure: This is raised in about 10% of cases. When raised, there is an increase of the pulse pressure over the normal average of 40, e.g., systolic 180 and diastolic 100. Localised areas of pre-tibial myxœdema (*myxœdema circumscriptum thyrotoxicum*) are met with in some cases. Similar patches may occur on the back of the leg. There is mucoid degeneration of the connective tissue. The fingers or toes may be clubbed. The electrocardiogram: This is normal in over 30% of cases, and flat or inverted T waves are the commonest abnormality. The blood: Lymphocytosis has been described but is not characteristic. The sedimentation rate of the red cells is occasionally raised. The sugar tolerance is often diminished although the resting blood sugar may be normal. The blood cholesterol is usually low, below 140 mg. per 100 ml. (normal, 140 to 280 mg. per 100 ml.). The average amount of serum protein-bound iodine (P.B.¹²⁷I) in the metabolically normal adult is 6.6 micrograms per 100 ml. In thyrotoxicosis the values vary between 8 and 35 micrograms per 100 ml. The patient must not have had iodine by mouth for 7 days, a pyelogram for 4 weeks, a cholecystogram for a year, and a bronchogram ever. The percentage uptake of radioiodine, after giving by mouth a tracer dose of 30 to 50 microcuries of ¹³¹I, is increased in thyrotoxicosis. The percentage amount in the thyroid gland is estimated by a Geiger-Müller counter at 24 hours. Normally the gland retains 80 to 40%, in hyperthyroidism between 40 to 90% is present in the gland, and in hypothyroidism the figure is between + and - 10%. There is some overlap

in these figures, for at times in thyrotoxicosis less than 80% is retained at 24 hours. The urine: There may be glycosuria after a carbohydrate-rich meal, but often the renal threshold is raised so that no glycosuria occurs when the blood sugar reaches the normal leak point of 180 mg. per 100 ml. Creatinuria is often found on a creatine-free diet. Marked polyuria, resembling that of diabetes insipidus, is noted in some cases. Decalcification of bones is very constantly met with, and calcium balance experiments show an increased loss both of calcium and phosphorus in thyrotoxicosis. The basal metabolic rate is increased to a varying degree, usually between +20% and +60%. In *thyrotoxicosis factitia*, due to self-administration of thyroid, the B.M.R. is raised, but the radioiodine uptake is not increased.

Differential Diagnosis. A typical case presents no difficulty. In an early case there may be unilateral exophthalmos, when Graves' disease has to be differentiated from other causes such as a retro-orbital tumour, transverse sinus thrombosis, or a general disease such as chloroma or xanthomatosis. Here a determination of the B.M.R. or radioiodine uptake is a valuable aid to the clinical findings. The normal B.M.R. range is between -15 and +15 (Robertson Reid). If there is doubt whether thyrotoxicosis is present the B.M.R. should be repeated after two weeks iodine treatment. In a case of thyrotoxicosis the B.M.R. will fall with the iodine. Exophthalmic ophthalmoplegia is thought to be due to the action of the pituitary thyrotrophic hormone. It is an example of a localised myopathy associated with thyrotoxicosis, past or present. Individual movements of the eye, especially elevation, are affected rather than individual muscles. It may follow thyroidectomy (malignant exophthalmos) and then be associated with myxoedema, or the ophthalmoplegia may antedate the severe exophthalmos. Early pulmonary tuberculosis may cause difficulty owing to the similarity in both diseases of such symptoms as loss of weight, tachycardia, weakness and reflex cough. Loss of weight, frequency of micturition and glycosuria may suggest diabetes mellitus. In pregnancy the P.B.¹²⁷I and the B.M.R. are raised; the radioiodine test must not be used owing to danger to the foetus. A toxic adenoma must also be differentiated, and milder forms of simple hyperthyroidism.

Course and Complications. The course is usually prolonged with definite remissions and exacerbations of the toxic symptoms, for periods up to 10 or 20 years. Gastro-intestinal crises with severe vomiting and diarrhoea may occur, or thyroid crises in which the pulse suddenly becomes extremely rapid with great exhaustion, or delirium. Fulminating cases with a rapidly progressive course, fever and mania are described. Complications include myocardial degeneration, heart failure, exophthalmic ophthalmoplegia, malignant exophthalmos, ulceration of the eye, myxoedema and diabetes mellitus. In some cases there is acute thyrotoxic myopathy, characterised by profound muscular weakness, which responds to iodine treatment. Chronic thyrotoxic myopathy is characterised by extreme muscular weakness and is cured by treatment of the thyrotoxicosis. Thyrotoxic periodic paralysis is a condition in which thyrotoxicosis is associated with familial periodic

paralysis. In some cases thyroidectomy has cured the attacks. Rarely myasthenia gravis and thyrotoxicosis co-exist.

Prognosis. The disease is serious, but the prognosis has improved with the use of antithyroid drugs.

Treatment. *Thiouracil* and its derivatives are now seldom used.

Carbimazole (*Neo-Mercazole*) is put up in 5 mg. tablets. The dose is, for mild cases, 1 tab. 3 or 4 times a day; for average cases 2 tabs. 3 times a day; and for severe cases 4 tabs. 3 times a day. The maintenance dose is 5 to 30 mg. daily, the dose being gradually reduced to zero by the end of a year. Side-effects include skin rashes, nausea and agranulocytosis.

Potassium perchlorate (*Peroidin*) is put up in 50, 200 and 500 mg. tablets. The average initial dose is 1,000 mg. daily in 4 divided doses. The dose should be reduced to 250 mg. b.i.d. when the patient is euthyroid, as judged by the serum protein-bound iodine. This is usually in about 8 weeks. The treatment is continued for a year. Mixtures containing iodide must not be given simultaneously. Toxic symptoms are not common, they include nausea, a maculo-papular rash and rarely agranulocytosis and aplastic anaemia.

Thyroidectomy. This has been made comparatively safe since the introduction by Plummer of the preliminary iodine treatment. Iodine is administered in the form of Lugol's solution (liq. iodi aquosus B.P. Add.). One drop of Lugol's solution = 6 mg. iodine. Ten drops are given t.i.d. in 1 fl. oz. (30 ml.) of milk. The iodine usually causes a reduction of the pulse rate and diminution of nervous symptoms. *Neo-Mercazole*, given as recommended above to reduce the toxicity of the goitre, combined with iodine for 5 days before the operation, is preferred by some surgeons and is especially valuable in severe cases of Graves' disease, which do not respond to iodine therapy alone.

Partial thyroidectomy is indicated when the goitre is very large or causing pressure symptoms, for a retrosternal goitre, or for a markedly nodular goitre. It is also advisable when a relapse has occurred after an adequate course of treatment with an antithyroid drug in patients under the age of 45, or when antithyroid drugs have been abandoned owing to sensitivity reactions. Men usually respond less well to antithyroid drugs than do women.

Should a thyrotoxic crisis occur after the operation, intravenous iodine should be administered in the form of Lugol's solution 10 m. (0.6 ml.) in 20 ml. of normal saline containing 10% of dextrose. This should be injected intravenously every 8 hours until the pulse rate falls. In the average case, which has been successfully operated on, work should not be resumed for at least 2 months.

Radioiodine. This treatment is becoming more popular, but facilities for its administration are not always available. It is wise not to give it to patients under the age of 50 years. A tracer dose of 80 to 50 microcuries of ^{131}I is given by mouth and the percentage uptake in 24 hours is determined. From this figure and the estimated weight of the thyroid the therapeutic dose is calculated. This is usually between 4 and 14 millicuries by mouth. If the thyrotoxicosis is not cured in 3 months the

dose can be repeated. Special precautions have to be taken when radioactive substances are administered. There is no danger of producing sterility. Whether or not carcinoma of the thyroid or leukaemia may develop after an interval of many years is not yet known.

Malignant exophthalmos in Graves' disease is a very serious condition, with often a hopeless prognosis. Encouraging results have been obtained by the administration of large doses of prednisone, 140 mg. daily for a week, reduced to 120 mg. daily for 2 to 3 weeks, then gradually reduced to 80 mg. daily, and later to 50 mg. daily. The final result, however, remains uncertain.

In some cases of severe Graves' disease maniacal symptoms occur. For these hyoscine hydrobromide, 1/200 gr. (0.8 mg.) should be injected subcutaneously and Lugol's solution given in doses up to 100 drops in the 24 hours. Intravenous iodine injections, as detailed above for the treatment of a thyrotoxic crisis, should be administered if the patient is vomiting. If the vomiting is severe rectal salines should also be given preferably by the continuous drip method, using 5% dextrose in normal saline.

X-ray treatment to the thyroid gland is rarely of value and in severe cases sudden death may occur.

Congenital Thyrotoxicosis

This is a rare condition occurring in babies of women who are, or have been thyrotoxic. It may be due to transference of LATS across the placenta from mother to foetus. It usually subsides about 3 months after birth, as the maternal gamma-globulin disappears from the infant's blood.

Masked Hyperthyroidism

There are some cases of cardio-vascular disturbance due to hyperthyroidism, in which no enlargement of the thyroid gland can be detected, and in which there are no obvious eye signs. The patients are usually over 40. The positive features suggesting the diagnosis are: Palpitations, atrial fibrillation, either paroxysmal or continuous, especially if resistant to digitalis or quinidine treatment, cutaneous vasodilatation, loss of weight, sweating, pigmentation, a tendency to diarrhoea and nervousness and a slight degree of staring of the eyes. The diagnosis is confirmed by the laboratory tests. In some cases the B.M.R. is only slightly raised, or is thought to be normal, but after 14 days' iodine treatment it falls, showing that it was above the patient's normal reading.

Treatment. This is as for Graves' disease.

Toxic Nodular Goitre

(Secondary Graves' Disease. Secondary Thyrotoxicosis)

Definition. A disease characterised by the presence of one or more adenomata in the thyroid gland, later followed by thyrotoxic symptoms.

Etiology. The proliferation of the adenoma may be due to deficiency

of iodine. The toxic adenoma may secrete excessive amounts of thyroid hormone, in the absence of the thyroid stimulating hormone.

Pathology. Proliferation of the lining epithelium of the adenoma does not usually occur. The follicles contain colloid, or the adenoma may be filled with spheroidal cells conforming to the foetal type.

Clinical Findings. The patient is usually an adult over the age of 35, who has had a goitre for some years. Symptoms of hyperthyroidism then appear insidiously.

On Examination : The noteworthy features are the presence of an adenoma in the thyroid, the absence of exophthalmos and acute nerve crises, and the liability to atrial fibrillation. The other signs are as for Graves' disease, but the eye signs are not present.

Differential Diagnosis. There is sometimes difficulty in distinguishing secondary from primary Graves' disease. If the adenoma is small or retrosternal it may not be palpable, and a clear-cut history of goitre antedating by several years the thyrotoxic symptoms will not be obtained.

Course and Complications. The course is typically progressive without remissions. Myocardial degeneration is common in untreated cases.

Prognosis. This depends upon the treatment. If recognised early and treated adequately there is good hope of permanent recovery.

Treatment. An operation is indicated in the majority of cases, especially when the gland is producing pressure effects and also owing to the possibility of malignancy.

Hypothyroidism

Cretinism

(Primary or Congenital Hypothyroidism)

Definition. A disease resulting from congenital deficiency of thyroid secretion.

Etiology. The cause is unknown. Cretinism may be associated with deficiency of iodine in the diet of the mother during pregnancy. It is more common in goitrous districts (endemic cretinism), the parents being goitrous, but it also occurs sporadically, especially in England, when the parents rarely have a goitre. The sex incidence is about equal.

Pathology. The thyroid gland may be absent (athyreosis), or small and undeveloped, and show atrophy of the vesicular epithelium, with overgrowth of the connective tissue. Adenomata, containing little colloid, may be present in the gland of endemic cretins.

Clinical Findings. The cretin does not develop normally from birth. The features which attract attention are delay in growth, intelligence and movement. The teeth may erupt late, and constipation is often troublesome.

On Examination : A typical cretin presents a somewhat bloated appearance with lack of expression. The hair is scanty, dry and brittle, the individual hairs appearing to be set too widely apart. There may be a coarse down on the trunk, the forehead is low, the skin thick and dry, the nose flat, the tongue may be large, and the hands are podgy.

Pads of fat may be felt above the clavicles. The abdomen is prominent, and an umbilical hernia may be present. The thyroid gland may be difficult to feel or may be enlarged. The intelligence is of a very low grade, the child being practically an idiot, but quiet and easily managed. The pulse is slow, the temperature subnormal and the basal metabolic rate low (such as — 40%). X-ray examination may reveal delay in ossification of the bones, but there is no overgrowth of the epiphyseal cartilage.

Differential Diagnosis. In infancy the condition must be diagnosed from Mongolism, congenital or acquired mental deficiency, such as follows encephalitis lethargica, or other varieties of dwarfism. In Mongolism (Down's syndrome) the appearances are characteristic. With congenital mental deficiency the baby may appear normal, but difficulty may be noticed in swallowing solid food or in sitting up, or there may be a squint. In dementia following encephalitis lethargica the child is often excitable, resembling an animal.

Course and Complications. The course depends upon efficient treatment and the date of its commencement. An untreated cretin becomes an unintelligent dwarf who is often a deaf mute and lacks sexual power. If not treated for some years, but little improvement can be expected, especially as regards mentality. Complications are usually due to intercurrent disease.

Prognosis. This is good if the condition is recognised and treated early, but thyroid extract will probably be needed during the whole of life and the mentality is usually, but not invariably, subnormal. The response to thyroid treatment is not so good in endemic cases.

Treatment. Prophylactic. In goitrous districts expectant mothers should be given *sod. iod.* 1 gr. (60 mg.) t.d.s.

Curative. The initial dose of thyroid for a cretin should always be small, such as thyroideum $\frac{1}{4}$ gr. (15 mg.) or 0.025 mg. thyroxine sodium, increasing to 1 or 2 gr. (60 to 120 mg.) or 0.1 or 0.2 mg. thyroxine sodium t.d.s., according to the age of the child and the response obtained. Sufferers from thyroid deficiency are much more susceptible to thyroid extract than are normal individuals. Thyroid treatment should be discontinued temporarily during any intercurrent infection. The child should be weighed every week. An operation may be required to remove an adenoma causing pressure.

Toxic symptoms due to overdosage include tachycardia, sweating, vomiting, diarrhoea, restlessness and loss of weight. Should these appear, the thyroid must be stopped, and, when the symptoms have passed off, the treatment should be started again with a smaller dose.

Myxœdema

(Secondary or Acquired Hypothyroidism)

Definition. A disease due to acquired deficiency of thyroid secretion.

Etiology. The cause is unknown, except in cases resulting from too extensive removal of the gland (cachexia strumipriva), those due to hypopituitarism, or occurring as a sequel of Hashimoto's disease.

Resorcinol ointment, applied to varicose ulcers of the legs, may act as an antithyroid agent and cause myxœdema. A similar effect may be produced by other antithyroid substances, such as thiouracil and radioiodine. *Predisposing causes:* 1. Age : Usually between 30 and 60. 2. Sex : More common in women. 3. Heredity : Myxœdema may run in families.

Pathology. The thyroid gland is small. The vesicles are few in number and fibrous tissue is present. In some instances there is a colloid goitre. The skin shows an increase of subcutaneous connective or fatty tissue, but there is no œdema, and mucin is not present.

Clinical Findings. The patient is usually an adult over the age of 40, who notices the gradual onset of such symptoms as lack of energy, torpor, increase in weight, deafness, supra-clavicular swelling, loss of hair, dryness of the skin, sensibility to cold, and constipation. There may also be pains in the muscles of the arms or legs near the joints, stiffness and swelling of the fingers, and a painful swelling may occur in a large joint such as the knee. The patient feels better in hot weather. A few cases with an acute onset have been recorded.

On Examination : The face is somewhat round and expressionless, the skin has a yellowish tinge, but is red over the malar bones. The eyelids may be swollen and so semi-closed. The lips may be swollen and the voice low pitched or hoarse. The hair is dry and rather scanty, and the outer parts of the eyebrows are deficient. The tongue may be enlarged and speech and cerebration slow. The electrocardiogram may show low voltage curves with flat or inverted T waves. The tendon reflexes tend to be prolonged. The duration of the ankle-jerk can be measured by a kinemometer. The thyroid gland is usually small, the skin is dry, the hands are rather clumsy, and although the arms and legs appear swollen, there is no pitting on pressure. Supraclavicular pads of thickened subcutaneous tissue are characteristic. Ascites sometimes occurs. The heart may be dilated and the arteries thickened, but the blood pressure is not usually low, and may be high. The pulse is slow, the temperature subnormal, the basal metabolic rate is reduced to about -30%, and the sugar tolerance increased. The blood cholesterol is raised and varies inversely with the B.M.R. The serum protein-bound iodine is low, and the radioiodine uptake is also low (see p. 696). A macrocytic or microcytic anæmia may occur. The urine may contain a trace of protein. Menstruation may be irregular if the disease occurs before the climacteric.

Differential Diagnosis. The appearances of a typical case are characteristic. Obesity due to other causes must be excluded. The patient's relatives may think she is suffering from "nerves", or that she is a *malade imaginaire*. The absence of true œdema differentiates the swelling of the legs from that caused by cardiac or renal disease. Swelling of the large joints may suggest osteoarthritis due to other causes and swelling of the hands has been mistaken for rheumatoid arthritis. Some cases have been mistaken for essential hypertension and others for a cerebellar lesion owing to unsteadiness, tremors, nystagmus, slurring of speech, etc. Paralytic ileus has been described in severe

hypothyroidism in adults. The *forme fruste* of essential xanthomatosis must be distinguished from myxœdema. In the former the skin is smooth and the hair is fine, and the patient is mentally and physically alert.

Course and Complications. The condition is usually slowly progressive, but arrest may occur at any stage apart from treatment. There may be marked mental deterioration, even the so-called "myxœdematous madness." Complications are due to intercurrent infections. Death from hypothermic coma has been described.

Prognosis. There is usually marked improvement with treatment.

Treatment. Tab. thyroxine sodium should be given in doses of 0.05 mg. t.i.d., increased to 0.1 mg. or more t.i.d. Care must be taken to give small doses, or palpitations, angina or cardiac failure may ensue. The return of the blood cholesterol to normal usually indicates that a sufficiency of thyroid is being given although the B.M.R. may still be below normal. The urinary output is usually increased by the thyroid treatment. Vitamin B₁₂ is required for macrocytic anæmia. Constipation should be treated by attention to the diet, and the use of laxatives if necessary.

For coma the patient should be wrapped in blankets in a warm room. L-tri-iodothyronine sodium, 100 micrograms, should be given intravenously b.i.d. for 24 hours, reduced then to 50 micrograms b.i.d. and to 20 micrograms t.i.d. When the patient can swallow thyroxine, up to 0.1 mg. t.i.d. should be given by mouth. At the beginning of treatment hydrocortisone also should be injected intravenously b.i.d. for a week and then gradually reduced.

Masked Hypothyroidism in Adults

In masked hypothyroidism the patient presents no clinical features of myxœdema, but the B.M.R. is low and the symptoms are relieved by thyroid extract. Examples are afforded by certain cases of angina of effort, secondary amenorrhœa and dermatomyositis.

Acute Thyroiditis

(*de Quervain's Thyroiditis*)

Acute thyroiditis is uncommon, and is more likely to affect a patient who has a goitre than one whose thyroid gland is normal. Young people are chiefly affected. It may complicate influenza, scarlet fever, typhoid fever, puerperal septicæmia, etc., or occur apparently spontaneously. The thyroid often swells suddenly, and there is pain, dyspnoea and dysphagia. There is some fever and at times there are rigors. Unless abscesses form the swelling usually disappears in a few days. Cold applications should be applied to the neck, and sedatives, such as pot. brom. 10 to 15 gr. (0.6 to 1 G.) given t.i.d. In severe cases prednisone, 15 to 20 mg., should be given daily.

Riedel's Disease*(Eisenharte Strumitis)*

A portion of the thyroid gland becomes extremely hard, like iron, suggesting a malignant tumour. The surface of the gland, however, is smooth and lymph nodes are not involved. The change is a chronic inflammatory one, with fibrous tissue formation, possibly secondary to perithyroiditis. The fibrous tissue in the affected portion of the gland invades surrounding structures such as the trachea and cervical muscles, and the carotid sheath. Men and women are equally affected, and it may occur in young people. There are often symptoms due to pressure on the trachea, œsophagus or recurrent laryngeal nerve, and pain may be referred to the ear. These symptoms may be out of proportion to the size of the tumour. The skin does not adhere to the swelling. Owing to the difficulty in distinguishing it from a malignant tumour, removal by operation is advisable, but complete removal may be impossible on account of its adhesion to surrounding structures.

Hashimoto's Disease*(Lymphadenoid Goitre)*

The cause of this condition, first described by Hashimoto, is thought to be due to autoimmunisation of the patient against his own thyroid gland. If colloid leaks into the stromal tissue of the gland antibodies to thyroglobulin are produced in the reticulo-endothelial cells. The gamma globulin is raised in Hashimoto's disease, and this fraction of the serum proteins is largely composed of antibodies. The antibodies may be detected by a precipitin test on the patient's serum, by a complement fixation test which recognises the antigen in the thyroid cells, and by the tanned red cell agglutination test. The precipitin and tanned red cell agglutination tests recognise the antibodies to thyroglobulin. The latter is much more delicate than the precipitin test, and is positive in about 93% of cases of Hashimoto's disease and in 65% of cases of primary myxœdema. Red cells, treated with dilute tannic acid, are coated with purified thyroglobulin. If these cells are placed in contact with serum containing antibodies to thyroglobulin they agglutinate. Women over the age of 45 are chiefly affected. The thyroid is firm and infiltrated with lymphocytes and the normal colloid is absent. The gland is uniformly enlarged and various pressure effects may be noticed. Myxœdema may ensue. Treatment consists in the administration of thyroid extract or thyroxine sodium for the deficiency symptoms and to reduce the size of the gland. Operation is contraindicated as it produces severe myxœdema.

Tumours of the Thyroid

Simple tumours include an adenoma, a fibroma and a papilloma, which are rare. A teratoma is uncommon and gumma extremely rare. A parathyroid tumour may be situated in the thyroid and resemble clinically a thyroid adenoma. Carcinoma is not very uncommon. It is

usually a primary growth, but may be secondary to a tumour in the breast, tongue, or stomach, or the gland may be involved by a direct spread from carcinoma of the œsophagus. The characteristic features are the stony hardness of the tumour, its tendency to adhere to the skin, trachea or larynx, and the pressure symptoms due to deviation of the trachea, compression of the œsophagus or involvement of adjacent nerves, such as the recurrent laryngeal and sympathetic. Pain may be felt in the ear. Secondary deposits are very liable to form in lymph nodes, the lungs, bones, the liver, the eyes and in the skin. The diagnosis is often very difficult, but malignancy should be suspected if a tumour grows rapidly after a period of inactivity, if it becomes very hard, and if, in addition, toxic symptoms develop. The early onset of dysphagia is also very suggestive. Treatment is surgical, followed by the administration of radioiodine, but the prognosis is usually grave. A secondary deposit in bone can give rise to hyperthyroidism after thyroidectomy. Its removal may lead to myxœdema. In about 10% of metastases there is a favourable response to the oral administration of a large dose of ^{131}I , such as 200 millicuries. Sarcoma of the thyroid is very rare; it is usually a round-celled rapidly growing tumour.

Granulomata and Cysts

Miliary tuberculosis may affect the thyroid, and in secondary syphilis the gland may enlarge or a gumma may form later. A hydatid cyst may also develop in the gland. The cystic adenoma has been described on p. 693. A degeneration cyst is due to degeneration of an adenoma. Haemorrhage may occur into it. Retention cysts are also described.

THE PARATHYROID GLANDS

Introductory. There are usually four parathyroid glands, situated in close relationship to the middle third and lower poles of the posterior surface of the lateral lobes of the thyroid gland. Small accessory glands may be present in the upper or lower pole of the thymus or in the carotid sheath. Parathormone, the parathyroid hormone, regulates the renal excretion of phosphates. An increase in the hormone causes a diminished absorption of phosphate from the glomerular filtrate as it passes through the renal tubules. The lowering of phosphate in the blood leads to increased elimination of phosphate, and with it calcium, from the bones. Vitamin D has the reverse effect on phosphate, increasing its reabsorption through the renal tubules, and increasing deposition of calcium at the epiphyseal ends of the bones. In larger doses it causes hypercalcaemia. Parathyroidectomy in mammals causes tetany as the result of the fall in the blood calcium.

Hyperparathyroidism

Acute hyperparathyroidism is rare. The symptoms resemble those resulting from the injection of parathormone into the dog. It may

result from the accidental over-administration of parathormone, or be due to a parathyroid adenoma. The chief features are anorexia, nausea, vomiting, drowsiness, constipation, and low blood pressure. The blood urea and calcium are raised. The condition is liable to be mistaken for uræmia. *Chronic hyperparathyroidism* may be primary or secondary. Primary hyperparathyroidism is described below. Secondary hyperparathyroidism, with parathyroid hypertrophy may be met with in osteomalacia or in renal glomerular insufficiency.

Primary Hyperparathyroidism

(including *Generalised Osteitis Fibrosa Cystica*. Von Recklinghausen's Disease of Bone)

Definition. A condition characterised by specific changes in the chemical composition of the serum and extracellular fluids. At times the bony changes of generalised osteitis fibrosa are present.

Etiology. The disease is due to hyperparathyroidism.

Pathology. The bones are depleted of calcium and deformed. A parathyroid tumour is present, usually an adenoma of the principal cells. Rarely there is a carcinoma or a generalised hyperplasia of all the parathyroids. Calcification may occur in the kidneys. When generalised osteitis fibrosa is present the giant-celled tumours consist of osteoclastic cells. Some fibrosis occurs in the subperiosteum, bone and bone marrow, and there is local formation of new bone.

Clinical Findings. The patient is usually over the age of 20, of either sex, more often a woman. She complains of pains in the back, pelvis or limbs. Spontaneous fracture of a bone may occur. There is tenderness on pressure over the affected bones. The blood: The serum calcium may be as high as 28 mg. per 100 ml. (normal 9 to 11 mg.), and the phosphorus as low as 1 mg. per 100 ml. (normal 2.5 to 5 mg.). The alkaline phosphatase is increased when the bones are involved. In the majority of cases the bones are normal. The urine contains an excess of calcium. The calcium in the faeces is usually about normal. In some cases a parathyroid tumour may be felt, or it may only be discovered by an exploratory operation. X-ray examination may show the characteristic bony changes, diminished density and pale areas due to cysts.

Differential Diagnosis. Hypercalcaemia may be due to too large doses of vitamin D, or to massive doses of calcium and alkalis. It may also occur in bone diseases such as multiple myelomatosis, or in renal failure. The blood phosphorus is usually normal in these conditions. The case may be mistaken clinically for one of rheumatism, arthritis or osteomalacia. In some cases renal symptoms predominate, either due to the formation of calcium phosphate calculi or to renal insufficiency. Frequency of micturition may suggest diabetes insipidus. When bone changes are present the diagnosis is established by the X-ray and blood changes and by finding a parathyroid tumour, the removal of which arrests or cures the disease. Fragility of bones also occurs as a familial disease associated with blue sclerotics and progressive deafness. The

blueness of the sclerotics is due to the dark pigment of the choroid showing through the unduly transparent sclerotics. The deafness results from otosclerosis. The disease usually shows itself in the second or third decade. In *Albright's syndrome* (polyostotic fibroid dysplasia or osteitis fibrosa disseminata) the bone lesions tend to be unilateral with pigmentation on one side of the body.

Course and Complications. The course is usually progressive, unless adequately treated, death occurring from an intercurrent disease such as a pulmonary embolus, renal failure or exhaustion. Renal failure results in rise in serum phosphorus, fall in serum calcium and in the calcium in the urine, and so the diagnosis cannot then be made on chemical grounds. Pancreatitis may be associated with hyperparathyroidism.

Prognosis. This is good if the parathyroid tumour is removed early.

Treatment. An exploratory operation should be made in the neck, and a parathyroid tumour searched for and removed. The tumour may lie in an abnormal site, behind the œsophagus, in front of the second and third thoracic vertebræ, or in the thorax. Subsequently, the fall in the blood calcium is controlled by giving a diet rich in calcium and by the administration by mouth of tab. calcium lactate 60 gr. (4 G.) t.i.d. and vitamin D, 50,000 units daily, given as 1 tab. calciferol. fort. if there are symptoms of tetany. If the symptoms are acute 10 to 30 ml. of 10% calcium gluconate should be injected intravenously daily, until the blood calcium rises to normal (see p. 710).

Hypoparathyroidism

Deficient activity of the parathyroids results in tetany. The relationship of tetany to the parathyroid function is not clear in all cases.

Tetany

(*Spasmophilia*)

Definition. A symptom complex characterised by over-excitability of portions of the nervous system, with resultant muscular spasm.

Etiology. There are three main causes:—

1. Deficiency of calcium in the blood. In many cases of tetany the blood calcium is low, injection of parathormone or the administration of calcium by mouth, intramuscularly or intravenously, raises the blood calcium and relieves the spasms of tetany. 2. Alkalosis. This does not result in a decrease in the serum calcium. Alkalosis may increase the excitability of nerve fibres or nerve centres, or limit the available supply of oxygen to the muscles by altering the dissociation curve of oxyhemoglobin. 3. Potassium deficiency.

Hypocalcemia. This may be due to: 1. Parathyroid Deficiency. It may result from operations on the thyroid gland (tetania parathyreopriva). It also occurs in Graves' disease where the parathyroids may be involved. 2. Deficient Absorption of Calcium. Infantile tetany associated with rickets results from deficient absorption of calcium owing to lack of vitamin D. Osteomalacia in adults may be due to a similar cause.

Tetany may also complicate cœliac disease, sprue, dysentery, cholera and Hirschsprung's disease.

Alkalosis. Gastric causes include pyloric stenosis and the administration of large doses of certain alkalis in the treatment of peptic ulcer. It has been noted in chronic arsenic poisoning, in which there is prolonged vomiting. It may also occur in high intestinal obstruction and nephritis. Hyperpnœa is a comparatively common cause of tetany. It may be hysterical, voluntary, or result from excessive exercise. In very hot and humid climates hyperpnœic tetany may occur, and fireman's cramp in some cases is probably due to alkalosis, in others to loss of chlorides.

Potassium deficiency. This may be due to hyperaldosteronism, with a normal serum calcium.

Tetany is said also to occur as the result of certain poisons such as chloroform, lead and morphine, and to be associated with some nervous diseases such as syringomyelia or cerebral tumours. The explanation of these conditions is obscure, unless there is hyperventilation. It may also be associated with pregnancy and lactation, possibly due to excessive demands for calcium, and to deficient absorption of calcium as in osteomalacia.

Pathology. The spasms affect chiefly small voluntary muscles; it is not known whether they are neurogenous or myogenous in origin, but certainly both motor and sensory nerves are hyperexcitable. It is doubtful if involuntary muscles are affected.

Clinical Findings. Infantile tetany occurs in rickety children between the ages of 6 months and 2 years; they often have diarrhœa. The tetany may show itself by attacks of laryngo-spasm or by carpo-pedal spasm, or by general convulsions. A case of post-operative tetany of mild degree illustrates well the condition seen in adults. The patient complains of attacks of tingling or numbness in the fingers, with stiffness in the fingers or arms, and then contractions of the hands, the thumb being pressed across the palm, causing pain. The feet may also be affected, becoming stiff, the ankles turning in and the toes being flexed. Twitching may be noticed in various muscles of the body, and the face and the lips may feel tight during an attack, causing difficulty in speech or swallowing. The attacks may come on suddenly and be provoked by raising the arms or lying still in a fixed position. The patient may also have convulsive fits with or without loss of consciousness. Vision may periodically become dim, and finally be lost owing to cataract.

On Examination: During an attack carpo-pedal spasm is typical. The hands are fixed in the accoucheur's position, with the thumb flexed across the concave palm, fingers adducted and flexed at the metacarpophalangeal joint, and extended at the interphalangeal joints. The wrists and elbows may be flexed. The feet: The ankles are dorsiflexed and may be inverted, with toes flexed and the sole concave. The knees are extended. The feet and hands may be congested. The corners of the mouth may be depressed and the lips protruded (carp mouth). Spasm may also affect the abdominal muscles, or diaphragm and intercostal muscles, causing expiratory apnœa, and lateral deviation

of the eyes may occur. In a long-standing case the skin is dry, the nails brittle, the teeth become carious and the hair falls out. Cataract may develop, and in its early stages can be detected by seeing opacities with the slit-lamp. In severe cases general convulsions may occur in adults. The increased irritability of the neuro-muscular system in latent tetany may be demonstrated by the following signs: *Chvostek's sign*. A tap over the facial nerve in front of the lobe of the ear provokes varying degrees of contraction of the muscles supplied, such as twitching of the angle of the mouth, of the outer canthus of the eye, cheek, forehead and *ala nasi*. *Trousseau's sign*. Compression of the upper arm by a sphygmomanometer armlet, with a pressure sufficient to obliterate the radial pulse, provokes spasm of the hand in 1 to 5 minutes. This may not be present in a well-developed case. *Schultze's sign*. A localised dimpling occurs on tapping the protruded tongue with a patella hammer. *Pool's sign*. Extension of the brachial plexus, by forcible abduction of the arm, causes spasm in the hand and arm. *Schlesinger's sign*. Flexion of the hip with the knee extended causes spasm of the leg. *Erb's sign*. There is increased excitability of motor nerves to galvanic stimulation. A kathodal opening contraction will occur with a current of less than 5 milliampères, applied to such a nerve as the common peroneal. *Hoffman's sign*. Stimulation (mechanical or electrical) of a sensory nerve will cause a muscular spasm. In post-operative tetany the serum calcium is usually below 7 mg. per 100 ml. As the calcium falls the serum phosphorus rises.

Differential Diagnosis. In infants other causes of convulsions must be considered (see p. 313). *Laryngospasm* must be differentiated from other causes of laryngeal obstruction (see p. 130). *Carpopedal spasm* occurs only in tetany and is diagnostic. In adults, generalised convulsions due to tetany have been mistaken for epilepsy; the patient does not, however, always lose consciousness, and there is much pain. Convulsions and mental deterioration due to hypoparathyroidism may first appear as long as 33 years after thyroidectomy. Tetanus and strychnine poisoning are usually easily differentiated. Between the spasms the special signs described above are of value. Hysterical spasms are not usually bilateral. A few cases of magnesium deficiency have been recorded, in which the other electrolytes were normal. There were no spontaneous muscle cramps, Chvostek's sign was positive and Trousseau's sign negative. There was a liability to epileptiform convulsions.

Course and Complications. Recurrence is very liable to occur; the attacks may last a few minutes, or persist for hours or days. Cataract is an important complication.

Prognosis. Tetany is a serious condition. In infants it may prove fatal with laryngospasm or generalised convulsions, and in adults it is especially serious in association with childbirth, gastric dilatation, nephritis, or after operation on the thyroid.

Treatment. Prophylactic. In infants prophylactic measures are to be directed to the prevention of rickets.

Curative. The spasms, if violent, may be controlled by administration of chloroform as a temporary measure of urgency. Morphine

should never be given. If the blood calcium is below normal, a diet rich in calcium, such as eggs, milk and green vegetables, should be given. The optimum daily intake of calcium for a child is 1 G., and for an adult 0.75 G. A quart (1.2 litre) of milk contains 1 G. of calcium. Calcium should also be administered as calcium lactate 5 to 240 gr. (0.3 to 16 G.) t.d.s. by mouth, or injected slowly intravenously as calcium gluconate, 10 to 20 ml. of a 10% solution, daily, until the symptoms are relieved. When calcium is given by mouth vitamin D should also be given, such as liq. calciferol., 4,000 i.u., 20 m. (1.2 ml.) t.i.d. daily. High potency Ostelin tablets containing 50,000 i.u. may be given, 2 tabs. daily for 5 days a week, without additional calcium. Even when the blood calcium is below 6 mg. per 100 ml., it is seldom necessary to give intramuscular injections of parathormone. A fraction of irradiated ergosterol, dihydrotachysterol or A.T. 10 (anti-tetanic substance No. 10), which does not contain vitamin D, when taken by mouth raises the blood calcium. It is put up as an oily solution in bottles of 15 ml. Three to 10 ml. are taken daily for 3 days followed by a weekly maintenance dose of 1 to 7 ml., but blood calcium estimations are essential as hypercalcaemia is liable to occur. Parathyroid extract by mouth has no effect in raising the blood calcium, as the active principle is destroyed in the stomach. Cataract requires treatment by operation.

Constipation should be relieved by an enema, and a colonic washout given every other day, with 1 to 2 pints (600 to 1,200 ml.) of normal saline, until the muscular excitability is normal. Sedatives such as chloral hydrate 5 to 10 gr. (0.3 to 0.6 G.) t.d.s. by mouth for an adult may be necessary for the first 2 or 3 days. If there is gastric dilatation, a tube should be passed and gastric lavage performed with normal saline. When the calcium in the blood has been restored to normal the patient should be kept on a diet rich in milk and eggs, and calcium lactate, 5 to 10 gr. (0.3 to 0.6 G.) given daily. Spontaneous hyperventilation tetany can be terminated by breathing air containing excess of CO₂. Tissue acidosis resulting from muscular activity may be the cause of spontaneous termination of hyperventilation tetany. In other cases of tetany due to alkalosis the treatment is as described on p. 680.

Idiopathic Hypoparathyroidism and Pseudo-Hypoparathyroidism

These are rare conditions. In *idiopathic hypoparathyroidism* the parathyroids are fatty, and the parathormone secretion is deficient. The disease may first manifest itself with epileptiform convulsions or with dementia. In addition there is tetany, a low serum calcium and a high serum inorganic phosphate. There is often thickening of the skin, scanty hair, cataract, calcification of the basal ganglia of the brain, and thickening of the cortex of the long bones.

In *pseudo-hypoparathyroidism* the parathyroids are normal or hyperplastic, but the tissues are resistant to the parathormone secretion. The patient is often short of stature, with a round face, and presents the other features of hypoparathyroidism. The treatment for the two conditions is the same, the administration of dihydrotachysterol or of calciferol.

THE ADRENAL GLANDS

Introductory. The adrenal gland is composed of two parts, a cortex and medulla, which in elasmobranch fishes remain separate; the cortex forming an inter-renal body. Further, the carotid body, the paranglionic bodies and accessory adrenals belong to the same system. The cortex is derived from mesoderm and is composed of cells containing lipid granules. The medulla is of sympathetic nervous origin and contains chromophil cells around which preganglionic branches of the splanchnic nerves end. The cortex of the glands is necessary to life. Watery extracts of the adrenal cortex contain a relatively small amount of the cortical hormones, but possess to some degree both carbohydrate and sodium regulating properties. Such a preparation is Eucortone, 1 ml. of which is equivalent to 75 G. of the adrenal cortex. About 30 crystalline steroid substances have been isolated from the cortex, of which 6 are physiologically active. The hormone present in greatest amount is hydrocortisone, or compound F of Kendall. Cortisone, compound E of Kendall, is 17-hydroxy-11-dehydrocorticosterone. Other active steroids include 11-desoxycorticosterone, corticosterone, 11-dehydrocorticosterone and aldosterone. Cortisone has been synthesised from bile acids and other sources, and desoxycorticosterone has also been synthesised, and is available in the form of DOCA.

The adrenal cortical steroids fall into 3 groups.

1. *Mineralocorticoids.* The C_{21} steroids include aldosterone, deoxycorticosterone, corticosterone and cortisol. They all have salt and water retaining properties, and increase the excretion of potassium. *Conn's syndrome* is due to excess of aldosterone.

2. *Glucocorticoids.* These include cortisol, cortisone and corticosterone, and they affect carbohydrate, fat and protein metabolism, and excretion of water. They lead to insulin antagonism, gluconeogenesis (conversion of protein to carbohydrate with storage of fat) and hyperglycæmia. There is increased breakdown of protein, with a negative nitrogen balance. The glucocorticoids are excreted in the urine, and estimated as 17-ketogenic steroids (17-oxogenic steroids). *Cushing's syndrome* is due to excess of glucocorticoids.

3. *Sex Hormones.* Androgens, œstrogens and progesterone, are formed by the cortex in both sexes. The androgens are excreted in the urine and are classified as 17-ketosteroids (17-oxosteroids). They are concerned with protein anabolism, with the growth of pubic and axillary hair and the maturation of bone marrow. *The adrenogenital syndrome* is due to excess of sex hormones. The normal amounts of steroids in the urine in adults are:—

17-oxogenic steroids. Males 5 — 21 mg./24 hours.

Females 4 — 16 mg./24 hours.

17-oxosteroids.

Males 5 — 28 mg./24 hours.

Females 3 — 20 mg./24 hours.

The internal secretion of the medulla is adrenaline, and it is inert on oral administration. Noradrenaline is also produced in the medulla and

probably in adrenergic organs and nerves. It lacks the N-methyl group of adrenaline. When noradrenaline is given intravenously in normal saline it causes a rise of blood pressure with tachycardia. Noradrenaline is the sympathetic transmitter between nerve endings and the cells they activate. The results produced by adrenaline injection are similar to those caused by sympathetic stimulation. Adrenaline is poured forth into the blood in times of stress. The effects produced include dilatation of the pupils, rise of blood pressure, acceleration of the heart, erection of hairs, dilatation of bronchioles, transference of glycogen from muscles to the liver, increase in blood sugar and blood lactic acid, relaxation of intestinal muscles, and constriction of the intestinal sphincters and of the arterioles of the skin and splanchnic region. In times of stress also it is thought that adrenaline stimulates the anterior pituitary by way of the hypothalamus. This results in the production of ACTH which causes the adrenal cortex to secrete 11- and 17-oxysteroids. A fall in the circulating eosinophils is then produced.

Hyperadrenia

Hypertrophy and tumours of the adrenals may result in their overactivity.

The Cortical Tumours. These include an adenoma, adeno-carcinoma and carcinoma. An adrenal carcinoma often involves the kidney and metastases occur in abdominal and mediastinal lymph nodes, and in the lungs, liver and brain. The tumour may be functionally inert causing pressure effects, or physiologically active resulting in virilism in females or rarely in feminism in males. With the physiologically active tumours diagnosis is possible before metastases have occurred, and removal of the tumour is often successful. The condition is known as hypercortico-adrenalism or the adrenogenital syndrome.

The Adrenogenital Syndrome. This is due to an increased output of sex hormones, usually androgens and rarely oestrogens, due to hyperplasia or a tumour of the adrenal cortex. The disease usually affects females. It results in changes in the genitalia and sexual abnormalities. The output of androgens is increased in females; in males, if the oestrogen secretion is increased, there is feminisation.

Virilisation of Females. The patient is usually an adult female who develops hair on the face, a masculine growth of pubic hair, amenorrhœa, enlargement of the clitoris, shrinkage of the breasts, atrophy of the ovaries, an infantile uterus, increased muscular development, a coarse skin, acne, headaches and depression. The urinary 17-ketosteroids (17-oxosteroids) are increased in women. The 17-ketogenic steroids (17-oxogenic steroids) are increased in the adrenogenital syndrome in men.

Treatment. Cortisone or prednisone should be given, often followed by subtotal adrenalectomy.

Other varieties of the adrenogenital syndrome include *female pseudohermaphroditism*, and the *adrenogenital syndrome in children*.

Female Pseudohermaphroditism. The infant is born with partially male external genitalia and may be thought to be a boy. There are no

testes, and the vaginal orifice may be lacking. The female internal genitalia are rudimentary, and the clitoris is large. The excretion of pregnanetriol and of 17-ketosteroids (17-oxosteroids) is increased. The adrenals are hypertrophied.

Treatment. This includes the administration of cortisone, adrenalectomy, and plastic surgery, preferably in childhood.

The Adrenogenital Syndrome in Children. The disease here begins in childhood, with sexual precocity in either sex. The lesion is usually a cortical carcinoma rather than cortical hyperplasia. In girls there is a high androgen urinary excretion, with rapid growth and muscular development, hirsuties, enlargement of the clitoris, lack of breast development and often obesity. In boys the "infant Hercules" appearance is seen, with excessive muscular development, a low voice, premature sexual development, and growth of pubic, axillary and facial hair. There is excessive excretion of 17-ketosteroids.

Treatment. The cortical tumour, if present, should be removed. For cortical hyperplasia cortisone should be given, followed perhaps by partial adrenalectomy.

Feminization of Males. This is very rare, and is due to an adrenal cortical carcinoma. There is gynæcomastia, atrophy of the external genitalia, loss of libido and impotence. The urinary 17-ketosteroids (17-oxosteroids) are slightly increased, and there is considerable increase of the urinary 17-ketogenic steroids (17-oxogenic steroids).

Treatment. The tumour should be removed, but metastases generally occur.

Conn's Syndrome (primary aldosteronism). This is due to an adrenocortical tumour, usually an adenoma, which is secreting an excessive amount of aldosterone. The patient suffers from muscular weakness or paralysis, cramps, limb pains, hypertension, thirst, and polyuria. There is retention of sodium, with a low blood potassium level, and excessive excretion of potassium in the urine. A tumour should be removed.

The Medullary Tumours. The *phaeochromocytoma*. This tumour arises in the chromaffin tissue of the medulla or in the paraganglia of the sympathetic nervous system. The catechol amines adrenaline and noradrenaline are excreted in the urine. It may result in the paroxysms of high blood pressure, with severe headache, nausea, vomiting, shivering, sweating, pallor, tachycardia and fever. In other cases the blood pressure is continuously raised. Certain tests have been introduced to substantiate the diagnosis. In cases with sustained hypertension 5 mg. of phentolamine (Rogitine) may be injected intravenously. The patient must have no sedative for 24 hours before the test, and must lie quietly for half an hour before the test is made. The blood pressure is recorded on the other arm every half minute for 10 minutes. In an actively secreting tumour the systolic blood pressure falls by about 60 mm. Hg. and the diastolic pressure by about 25 mm. Hg. If the blood pressure falls too low methylamphetamine hydrochlor. (Methedrine), 30 mg., should be injected intravenously. With a *phaeochromocytoma* there is usually an increased excretion of noradrenaline in the urine. Thus

whereas the normal amount of pressor or catechol amines in the 24-hour excretion of urine is 50 micrograms, with a phæochromocytoma the excretion may rise to 100 micrograms or more. Treatment consists in removal of the tumour, special precautions being taken to combat the severe fall in blood pressure during the operation.

Other medullary tumours include the *ganglioneuroma*, which is benign, and the *neuroblastoma* which is very malignant. The latter affects children. When the right suprarenal is involved metastases occur in the liver (Pepper syndrome), and with the left suprarenal the bones and left eye may be affected (Hutchison syndrome).

In Graves' disease or after shock, overactivity of the adrenals may be present with diminished sugar tolerance and glycosuria, the sugar being derived from glycogen in the liver and muscles, and possibly from protein. At the climacteric some of the symptoms, such as rise of blood pressure, may be due to hyperadrenia.

Hypoadrenia

The most important manifestation of hypoadrenia is Addison's disease. Other conditions which may be associated with hypoadrenia are :—Circulatory failure and shock symptoms as in diphtheria, typhoid fever, scarlet fever and cholera. Hæmorrhagic necrosis of the adrenals may be the lesion in these cases. Acute adrenal hæmorrhage involving the medulla may occur in the fulminating type of meningococcal septicæmia, associated with a petechial rash. This is usually rapidly fatal and is known as the Waterhouse-Friderichsen syndrome. In congenital hydrocephalus the medulla of the adrenals has been found absent in some cases. Progeria may be due to a hypoplasia of the cortex.

Addison's Disease

Definition. A disease characterised by low blood pressure, gastrointestinal disturbances, weakness and pigmentation of the skin.

Etiology. Addison's disease is caused by a lesion of the adrenals, and less commonly of the splanchnic ganglia. It is rather more frequent in males.

Pathology. Addison, in 1855, based his description on 11 cases ; of these the adrenals were tuberculous in 5, carcinomatous in 3, fibrotic in 2, and an acute hæmorrhage had occurred in 1. In 4 of his cases only 1 gland was affected. The glands may also be gummatous, atrophic, suppurative, or affected by Hodgkin's disease or by a diffuse reticulo-endotheliosis, or they may be normal, but the splanchnic ganglia are then diseased. Atrophy is the commonest cause now, and this may be due to autoimmune disease. Pigmentation may be due to an increased secretion of a melanocyte-stimulating hormone from the pituitary, due to diminished production of hydrocortisone in the adrenal.

Clinical Findings. The patient is usually an adult between the ages of 20 and 40 who notices progressive weakness, loss of appetite, wasting, darkening of the skin, and coldness of the extremities. Pigmentation

may precede the other symptoms of Addison's disease by several years. Vomiting may occur from time to time or be very persistent, and there may be diarrhoea. Rarely the disease has an acute onset with hypoglycæmic coma.

On Examination: The patient appears somewhat wasted. There is chestnut-brown pigmentation of the skin, especially on the face, the backs of the hands, axillæ, round the nipples and navel, in the pubic region, and where there is pressure as at the waist or garter line. Small black spots may be seen, especially on the forearms; leucodermic patches may also occur, and the hairs growing from them may be blanched. Slaty pigmentation may occur on the tongue, the buccal mucous membrane, or in the conjunctivæ, anus or vagina. The blood pressure is low, usually below 100 mm. Hg. systolic. The pulse is somewhat frequent and the temperature usually subnormal, apart from active tuberculosis. Hypoglycæmic episodes are not infrequent. Calcification of the adrenals may be seen in some cases on X-ray examination of the abdomen. The blood: Microcytic hypochromic anæmia may be present, or the blood may be viscid. There may be a relative lymphocytosis with an eosinophilia up to 6%. The blood urea and non-protein nitrogen rise in the penultimate stage due to reduction in blood volume, hæmoconcentration and diminished renal blood flow, and so extrarenal azotæmia ensues. There is usually a fall in the sodium-potassium ratio below the normal of 30. The Na-K ratio is $\frac{\text{mEq. Na/L}}{\text{mEq. K/L}} = \frac{150}{5} = 30$. The 17-ketosteroids (17-oxosteroids) and total 17-oxogenic steroids in the urine are reduced or absent in women and in men. The basal metabolic rate is low. The electroencephalogram often shows abnormally slow waves. The following tests of adrenal cortical function may be carried out.

1. *Thorn's test.* The eosinophil response to ACTH. Normally after the intramuscular injection of 25 mg. ACTH the adrenal cortex increases the output of 11-17-oxosteroids, which causes a marked fall in eosinophils of over 50%. In adrenal cortical insufficiency the fall in eosinophils is less than 50%. The circulating eosinophils normally number 100 to 300 per c.mm. The first count is made in the morning after a night's fast. The ACTH is then injected, breakfast is taken, and the second count is made 4 hours after the first.

2. The 17-ketosteroid (17-oxosteroid) excretion response to ACTH. Normally the 17-ketosteroids excretion rises as the circulating eosinophils fall after the intramuscular injection of ACTH 20 units b.i.d. for 4 days. In primary adrenal deficiency there is no increased excretion. In adrenal deficiency secondary to anterior pituitary lesions there is a slight rise in the 17-ketosteroid (17-oxosteroid) excretion on the second day.

3. The Robinson-Kepler-Power test. This is not dangerous. It consists of two parts, the first concerned with the delayed excretion of water in Addison's disease, the second with an increased excretion of chloride in the urine, and relative retention of urea in the blood. A water load test is usually sufficient. The patient drinks no fluid after 10 pm. At 7 am. he empties his bladder. He then drinks 20 ml./kg.

body weight of water in the next half hour. The urine passed at 8, 9, 10 and 11 am. and the total volume are measured. In Addison's disease less than 80% of the water drunk is excreted. If so, the test is repeated a few days later, 100 mg. of cortisone being taken by mouth 4 hours before the water is drunk. This should increase the urinary output in Addison's disease.

4. Twenty-four hours starvation, during which only water is taken by mouth, will cause a fall in blood sugar of over 20 mg./100 ml., and hypoglycæmic symptoms may develop.

Differential Diagnosis. The weakness and pigmentation may suggest pernicious anæmia; this is excluded by a blood count. Other causes of pigmentation and gastric disturbance must be considered, such as arsenic poisoning, abdominal growths and pregnancy. Anorexia, nausea and vomiting may suggest chronic cholecystitis or appendicitis. Carcinoma of the stomach is excluded by the test meal, opaque meal, occult blood test in fæces, and the absence of a tumour or of secondary deposits. It may, however, co-exist with Addison's disease. In suspected arsenical poisoning the hair should be tested for arsenic. Other causes of pigmentation which may have to be considered are race, sunburn, dirt, silver and lead poisoning, hæmochromatosis, abdominal tuberculosis, acanthosis nigricans, and Graves' disease. A systolic blood pressure much over 100 mm. Hg. renders the diagnosis of Addison's disease very unlikely unless the patient has previously suffered from hypertension.

Course and Complications. The course, if untreated, is usually progressive, and complications such as intercurrent infections or myocardial degeneration may ensue. Crises may occur in which the patient is collapsed and appears moribund. The plasma volume is reduced. Death may be due to hypoglycæmic coma or renal failure.

Prognosis. This has been much improved by modern treatment. The most favourable cases are those in which the adrenal lesion is simple atrophy. Active pulmonary tuberculosis is a very grave complication.

Treatment. The best treatment appears to be the oral administration of cortisone tablets 25 to 50 mg. daily in divided doses at 8 a.m. and 3 p.m. Fluorohydrocortisone (Fludrocortisone) acetate causes water and salt retention but in excess it may cause heart failure. The dose usually required is one to three 0.1 mg. tab. daily. Substances rich in potassium should be avoided, they include peas, beans, lentils, soups, dried fruits and chocolate.

Should a crisis occur, the patient should be kept warm and the bed heated with an electric cradle. Hydrocortisone, 100 mg., should be injected in an intravenous drip of normal saline, and, as soon as the patient can swallow, he should be given cortisone by mouth in doses of 100 to 200 mg. in 24 hours.

Operation may sometimes be required for the removal of a tuberculous adrenal gland and kidney. The patient should be stabilised as described above, and 75 mg. cortisone acetate (25 mg./ml.) should be injected intramuscularly before, during and after the operation.

THE PITUITARY BODY

Introductory. The pituitary body is essential to life. It is composed of the following parts: *The anterior lobe* (pars distalis and pars tuberalis) formed of chromophobe or agranular, and chromophil or granular cells in columns, the latter being eosinophil or α cells and basophil or β cells, with connective tissue and blood vessels. In cases of adrenal cortical deficiency there is a reduction in the number of basophil cells. It is thought that the chromophobe cells are the "mother cells" of the granular cells from which a secretion is derived. The anterior pituitary hormones include the *growth hormone*, the *gonadotrophic hormones*, they are the follicle stimulating (FSH) and the luteinizing hormones (LH) in the female, and in the male the interstitial cell stimulating hormone (ICSH) or luteinizing hormone (LH): *Prolactin* or the lactogenic hormone: *Thyrotrophin* or the thyroid stimulating hormone (TSH): And the *adrenocorticotrophin* (ACTH). The growth hormone is thought to be produced by the eosinophil cells, and TSH and ACTH from basophil cells. The human growth hormone, which is effective in man, is extracted from pituitaries obtained at autopsies. It is now thought that the growth hormone and the adrenocorticotrophic hormones influence carbohydrate metabolism, and the the growth hormone also exerts a ketogenic effect. When the growth hormone is injected into dogs it causes diabetes. The interalveolar cell islets (islets of Langerhans) are thought to atrophy as the result of increased output of insulin to deal with the carbohydrate which is not utilised by the tissues.

The growth hormone is thought to be produced by the eosinophil cells. ACTH stimulates all the adrenal cortical hormones except aldosterone. It is much more powerful when given intravenously than when injected intramuscularly. The gonadotrophic hormones are believed to influence both the female and male genital systems. The follicle stimulating hormone (F.S.H.), in the female causes growth of the ovarian follicles and the liberation of the oestrogenic hormone, oestradiol. In the male, it acts on the testis and is concerned with spermatogenesis. The luteinizing hormone (L.H.), is responsible for the formation of the corpus luteum, for the secretion of oestrogens during the first half of the menstrual cycle, and the secretion of the ovarian hormone, progesterone. In the male the interstitial cell-stimulating hormone (ICSH) is concerned with the descent of the testicle and provokes the internal secretion of the interstitial cells, which is known as testosterone. Oestradiol is excreted in the urine both of women and men, and in women the amount excreted increases during pregnancy and during certain phases of the menstrual cycle. Progesterone is excreted in the urine as pregnanediol, and testosterone is excreted as androsterone. The presence in the urine of an anterior pituitary-like luteinizing gonadotrophic substance, originating in the chorionic tissue of the placenta, forms the basis of the Aschheim-Zondek test for pregnancy. It produces haemorrhagic follicles in the ovary of the sexually immature mouse. A similar substance is found in the urine in chorion epithelioma, hydatidiform mole, and malignant

disease of the testis. *Oestrogens* are a group of complex substances chemically related to sterols. They are excreted into the blood stream by the ovaries, placenta and adrenal cortex during the reproductive period of the female. The secretion is under the control of the anterior pituitary. The *oestrogens* are responsible for the development of the secondary sex characteristics. They are necessary for pregnancy, parturition and lactation. *Androgens* are similar chemically to *oestrogens* and are secreted by the testes and adrenal cortex. They are responsible for the male secondary sex characteristics.

Clinical Applications of the Gonadotropic Hormones. The available preparations are not usually derived from the pituitary but from the serum of pregnant mares and from pregnancy urine. They are presumably formed in the placenta. Those obtained from pregnant mares' serum more completely resemble the two pituitary gonadotrophic hormones than do those derived from human pregnancy urine, which are chiefly luteinizing in character. The former include preparations such as Gestyl, Gonadyl, and Serogan, and those from pregnancy urine include Antuitrin S, Gonan, and Pregnyl. They are used for the treatment of pituitary infantilism, undescended testis and sexual underdevelopment, and for certain types of metrorrhagia and sterility.

The pars tuberalis is difficult to demonstrate in man; its function is not known.

The pars intermedia. This is very variable in amount. It surrounds the posterior lobe and contains basophil cells. It secretes intermedin which has a melanophore-expanding effect on frogs and may also possess antidiuretic properties.

The posterior lobe (neurohypophysis) consists of neuroglial cells, ependymal cells and pyramidal granular cells, called pituicytes. There are also non-medullated nerve fibres, hyaline masses and blood vessels. The hypothalamic nuclei are thought to secrete two hormones, *oxytocin* and *vasopressin*. They travel along nerves to the pituitary and are stored in the posterior lobe. *Oxytocin* stimulates contraction of the uterus at childbirth, and aids in the ejection of milk. It also stimulates contraction of the intestines, gall bladder, ureters and urinary bladder. In animals it raises the blood pressure. *Vasopressin* (ADH) is antidiuretic. It acts on the renal tubules. It probably does not affect the blood pressure in man. The secretions leave the posterior pituitary by the blood stream.

The anterior lobe, *pars tuberalis* and *pars intermedia* constitute the glandular division and are derived from Rathke's pouch of the stomodæum, and the posterior lobe, infundibular stem, and median eminence constitute the neural division and are derived from the floor of the fourth ventricle. Disturbance of function is known as dyspituitarism, which may be in the sense of overactivity of any part or parts of the gland, constituting hyperpituitarism, or underactivity known as hypopituitarism.

Hyperpituitarism

Overactivity of the pituitary may give rise to sexual precocity or gigantism if it occurs before growth has ceased, or to acromegaly if it begins later.

In infancy hyperpituitarism may cause hemihypertrophy of the whole of one side of the child, or one leg only may be affected. This usually becomes unnoticeable as the child grows.

During childhood gigantism, height over 79 inches (2 metres) may ensue or pituitary glycosuria. Thus a boy of 9 years of age may be over 6 feet (1.8 metre) tall.

Cushing's Syndrome

This is associated with a basophil adenoma of the anterior lobe of the pituitary, which may be minute. In some cases no such tumour can be found, but there is hypertrophy or a tumour of the adrenal cortex. In other cases there is carcinoma of a bronchus, ovary, thymus, or carcinoma or insuloma of the pancreas. There is excessive production of glucocorticoids. Young women are chiefly affected, females are usually short and males tall. There is adiposity of the face, neck and trunk, but not of the limbs. Purplish cutaneous striæ are seen on the lower part of the abdomen and on the thighs. The blood pressure is raised and there is hypertrichosis in women of the chin, upper lip and side-whisker areas. The face becomes moon-shaped. The pubic hair has a male distribution. Hair tends to fall out on the head. Erythrocytosis occurs in some cases. The bones may be soft. There may be glycosuria. There is usually amenorrhœa or impotence. In addition to the pituitary and adrenal lesions the ovaries or testes may be found atrophied post-mortem.

In order to distinguish the condition from the adrenogenital syndrome special tests are required. The urinary output of total 17-ketogenic steroids (17-oxogenic steroids) is increased above the normal of 4 to 10 mg./24 hours for women and 5 to 21 mg./24 hours for men. These are metabolites of cortisol. The excretion of 17-ketosteroids (17-oxosteroids), which are metabolites of adrenocortical androgen, is little affected. Adrenocortical suppression tests help to distinguish between adrenocortical hyperplasia and an adrenal tumour. With hyperplasia the output of 17-oxogenic steroids will probably be depressed by the administration of dexamethasone, but this is not the case with an adrenocortical tumour as it is not controlled by the pituitary.

The blood electrolytes usually show a rise of sodium and chloride, and a fall of potassium. There is often a diabetic type of curve with a dextrose tolerance test. The presence of an adrenal tumour may be revealed by a straight X-ray of the abdomen, by an X-ray after perirenal air insufflation, by an intravenous pyelogram and by tomograms.

Arrhenoblastoma of the ovary is another cause of hirsuties, but in this rare condition the patient is not obese, cutaneous striæ, if present, are not purplish, and the blood pressure is seldom raised. A pituitary tumour (usually an agranular adenoma) may cause pressure symptoms such as loss of vision and headache, without symptoms of secretory disturbance. If it presses on the basophilic tissue, sexual deficiency symptoms such as amenorrhœa may occur. There may be optic atrophy with leg pains and absent knee-jerks (pituitary tabes) differing from tabes dorsalis clinically in that the pupils react to light.

Treatment. The pituitary may be treated by X-rays to diminish the ACTH output, or by implantation of radioactive yttrium-90 or gold-190, but blindness may ensue. Removal of a part or the whole of both adrenals, or of an adrenal tumour may then be performed, followed by substitution treatment with cortisone and fludrocortisone.

Stalk tumours. (suprasellar cysts). These cause headache and loss of vision. The sella turcica is often distorted and a shadow may be seen above it by X-rays. There may be early optic neuritis and later atrophy; clinically it closely resembles an adenoma of the pituitary. A suprasellar endothelioma may also occur.

Pituitary Glycosuria. This may occur in hyperpituitarism. The "diabetogenic factor" of the pituitary is thought to be closely associated with the growth hormone, to have the opposite effects of insulin, and directly to antagonise insulin. Possibly it may also damage the pancreatic islets.

Acromegaly

Definition. A disease characterised by enlargement of the extremities.

Etiology. Acromegaly is caused by oversecretion of the pituitary growth hormone.

Pathology. There is usually an eosinophil adenoma of the anterior lobe, less frequently the tumour is a glioma, endothelioma or sarcoma. There is often hyperplasia of the adrenal cortex.

Clinical Findings. The patient is usually between the ages of 20 and 40 at the onset. The disease may first show itself directly after pregnancy. The sex incidence is practically equal. The patient may first notice tingling or numbness of the hands and feet, and later enlargement of the head, face, hands or feet. He then complains of headache, often bi-temporal, and of visual disturbances such as dimness of the outer part of the fields of vision. Amenorrhœa may be the first symptom. Early there may be sexual excitement, but mental torpor develops later. There may also be loss of smell, trigeminal neuralgia or nasal discharges of blood, mucus or cerebrospinal fluid. In some cases the patient has attacks, known as "uncinate fits" with an aura of smell or taste, and convulsions may follow.

On Examination: In an established case the appearance is characteristic; the lower jaw, the malar bones and superciliary arches are prominent and the skull is enlarged. Twenty per cent of patients are over 5 feet 11 inches (1.8 metre) in height. The tongue is big, the teeth spaced, the nose broad, the skin rough, thick, and it may be dark. Neurofibromata may be present. The hands and feet are enlarged, the chest big, and there is frequently kyphosis. Pierre Marie described two types of hand, the *type en long*, and the *type massive*, which is spade-like. The thyroid gland is often palpable. The temperature is low in the later stages of the disease. The blood pressure may be raised.

Special Examinations. The eyes: The characteristic change is bi-temporal hemianopia, due to pressure of the tumour on the decussating fibres of the optic nerve in the chiasma. This is determined by plotting

the fields of vision. Early changes include primary optic atrophy and a scotoma for red. Optic neuritis rarely results from generalised increased intracranial pressure. The third, fourth or sixth cranial nerves may be compressed in the cavernous sinus with weakness of the ocular muscles. An X-ray of the skull: This may show enlargement of the sella turcica or erosion of one or both of the anterior or posterior clinoid processes. X-ray of the hands: A "tufting" appearance may be seen in the terminal phalanges which show lines radiating like a fan. Sugar tolerance test: In the early stages the tolerance may be diminished, the blood sugar rising above the renal threshold and glycosuria resulting. Later there is hypopituitarism with increased sugar tolerance. Basal metabolic rate: This may be increased early and diminished later in the disease.

Differential Diagnosis. The appearances of a developed case are typical. In the early stages the special examinations mentioned above will help in the detection of a pituitary lesion.

Course and Complications. The course is usually progressive, but there may be intermissions. Certain types are described: 1. *Benign*. Duration up to 50 years. 2. *Chronic*. Duration 8 to 80 years. 3. *Acute malignant*. Duration 8 to 4 years. 4. *Cephalic*. Head only affected. 5. *Stationary*. 6. *Formes frustes*. The headaches may become excruciating and blindness or dementia occur. Death may result from heart failure, convulsions, diabetes mellitus, uræmia or intercurrent infections such as pneumonia and tuberculosis.

Prognosis. This is very grave, but there is a tendency to arrest in some cases, and a cure has been effected by operation.

Treatment. X-ray treatment to the skull may afford relief or the implantation into the sella of radioactive yttrium-90 or gold-190. Operation is usually advised on account of threatened loss of vision or severe headache. A decompression and incision of the capsule of dura may relieve headache, even if the tumour is not removable. Insulin and dietetic restrictions may be necessary for the glycosuria.

Hypopituitarism

The effects produced by under-activity of the pituitary vary with the age of the patient. The characteristic features are sexual inactivity, infantilism, deposition of fat, lowered metabolism, and oversecretion of urine. The lesion, if an adenoma, is of the chromophobe type, and probably produces its effect by pressure on the chromophil cells of the pituitary. In other cases the symptoms are due to a persistence of chromophobe cells and improvement occurs as more granular cells are formed.

Pituitary Infantilism

The Lorain Type (Ateleiosis). The child does not grow, the trunk especially being short. The intelligence is good. The sexual organs are small but there is no adiposity. It is considered to be due to insufficiency of the anterior pituitary growth hormone. It may also occur with a craniopharyngioma.

Fröhlich's Type (Dystrophia adiposogenitalis). This was originally described in a boy of 14, and, at operation, a cyst the size of a hazel nut was found, which was thought to be in the pituitary. Histological examination suggested an adenoma of the pituitary. There was destruction of the sphenoid and dorsum sellæ, severe frontal headaches and blindness of the left eye. The disease may not commence until adult life. There is adiposity affecting the arms, legs and trunk, especially around the pelvis and below the scapulæ. The adiposity is probably due to a lesion of the neighbouring hypothalamus. The skin is smooth, the fingers tapering, the genital organs immature, the intelligence is usually normal but there is a tendency to somnolence (fat boy of Dickens). The blood pressure is often slightly raised. The temperature is subnormal and the sugar tolerance is increased. Males tend to conform to the female type. *The Laurence-Moon-Biedl syndrome* is characterised by obesity, polydactylism, mental deficiency, and retinal changes resembling those of retinitis pigmentosa.

Hypopituitarism in Adults

There is usually general obesity, especially around the pelvic girdle, and diminution of sexual function. The male skeleton and pubic hair distribution tend to conform to the female type. The fingers become delicate and tapering and the skin smooth. In females there is usually amenorrhœa.

Simmonds' Disease (Panhypopituitarism, anterior). This is due to deficiency of the anterior lobe, which is often found to be replaced by scar tissue, or which may be the site of an embolus, thrombosis or hæmorrhage. The original case was associated with puerperal sepsis. It may also follow a severe post-partum hæmorrhage with thrombosis of the pituitary blood vessels, or be caused by tumours or cysts. Some patients die during the puerperium. An emergency blood transfusion should be given in cases of collapse and severe hæmorrhage. Other patients survive for years and may be diagnosed as suffering from myxœdema. They may be weak, look old, have amenorrhœa, loss of pubic hair, a dry skin, apathy, convulsions and finally die in coma. It occurs in adults usually over the age of 30, and affects both sexes. There is usually, but not always, marked emaciation, with trophic changes in the teeth, hair and nails, loss of appetite, vomiting and profound weakness. The axillary and pubic hair are frequently lost. Sexual power disappears, the temperature and B.M.R. are low. The similarity to anorexia nervosa has been referred to. In some respects it resembles Addison's disease, but there is usually no pigmentation. In others it manifests itself as pituitary myxœdema or pituitary hypothyroidism. If untreated, death usually occurs in 1 to 2 years, in some cases due to hypoglycæmic coma. All grades of Simmonds' disease exist, from the very mild to the very severe. Complete recovery may occur if the patient becomes pregnant again. In panhypopituitarism the insulin sensitivity test shows hypoglycæmia unresponsiveness, and the 17-ketosteroid and 17-ketogenic steroids excretion is usually low. Hypoglycæmia unresponsiveness also occurs in Addison's disease.

Dercum's Disease (*Adiposis dolorosa*). This usually occurs in women after the climacteric. Painful, fatty, subcutaneous masses appear, especially in the upper arms and thighs, and there is general weakness and mental deterioration. In all cases of suspected hypopituitarism a sugar tolerance test should be performed. The tolerance is usually increased. The basal metabolic rate is low. An X-ray film of the skull may reveal alterations in the pituitary fossa, and visual disturbances may occur.

Treatment. This is not very satisfactory. If a tumour is present an operation may be necessary to relieve headache or preserve vision, if the tumour is insensitive to irradiation. In pituitary infantilism treatment should be begun with 0.05 mg. of thyroxine sodium. Oral administration of pituitary extract is probably without effect. Children may be given subcutaneous injections of growth hormone prepared from human pituitaries, if available. In Simmonds' disease cortisone should be given by mouth in doses of 12.5 mg., one to three times daily and for either sex methyltestosterone 10 mg. b.i.d., sublingually. Thyroxine sodium, 0.05 mg., gradually increased to 0.2 or 0.3 mg. daily should be given after 10 days' treatment with cortisone.

Diabetes Insipidus

Definition. A disease characterised by thirst and persistent polyuria, the urine being of low specific gravity and containing no abnormal substance.

Etiology. Probably all cases are due to lack of the anti-diuretic pituitary hormone (ADH), associated with hypofunction of the posterior lobe, or with lesions of the hypothalamus near the tuber cinereum. The nucleus supraopticus in the hypothalamus is probably the controlling centre as the ADH is formed here. Water-balance in the body is disturbed by loss of the oliguric hormone which normally affects the thin segment of the loop of Henle, stimulating it to absorb water and so to concentrate the urine. Normally 168.5 litres of glomerular filtrate are reabsorbed in 24 hours, and in diabetes insipidus this amount may be reduced to 130 litres. The amount of ADH leaving the posterior pituitary and entering the circulation is controlled by osmoreceptors situated in the internal carotid arteries. These respond to variations in the osmolability of blood and so regulate fluid excretion to maintain a constant osmotic blood pressure. In dehydration the output of ADH increases and the excretion of urine diminishes; in hydraemia the reverse occurs. The secretion of the thyroid gland also appears to increase water elimination and symptoms of diabetes insipidus are sometimes associated with thyrotoxicosis. *Predisposing causes:* 1. Heredity, especially in the benign idiopathic cases. 2. Age: 10 to 40 years. 3. Sex: Males predominate.

Pathology. The following lesions have occurred: Sarcoma, secondary carcinoma, a chromophobe adenoma, sarcoid, sphenoidal sinusitis, gumma or leukaemic infiltration of the pituitary; injury to the sella turcica as by a bayonet or bullet wound or fractured base, basal

syphilitic or tuberculous meningitis involving the interpeduncular fossa. It is also a symptom of the Hand-Schüller-Christian disease, and of post-encephalitic Parkinsonism. Experimental puncture of the hypothalamus, or compression of the infundibulum by a clip results in diabetes insipidus. At autopsy there may be enlargement of the kidneys, ureters and bladder.

Clinical Findings. The patient is usually a young adult, who notices increasing thirst and the passage of large quantities of urine. Rarely there is no thirst. There may be a sudden onset after an injury. He is usually constipated, the mouth is dry, and sleep is disturbed by the desire for micturition. Sometimes there is great hunger and thirst becomes unquenchable.

On Examination : In an established case there is usually emaciation with a dry skin. Neighbourhood symptoms may be present if the lesion is a tumour. The urine : Specific gravity 1.001 to 1.005. Volume 10 to 40 litres daily. There is no protein, but occasionally a trace of sugar may be present. The blood : The red cells may be over 6 millions per c.mm. The Wassermann reaction may be positive. The sugar tolerance is normal or diminished. The basal metabolic rate is usually normal. An X-ray film of the skull may show enlargement of the sella turcica.

Differential Diagnosis. Other varieties of polyuria and frequency must be excluded, especially those due to chronic nephrosclerosis, intermittent hydronephrosis, diabetes mellitus, hysteria and an enlarged prostate. The renal function tests and abnormal urinary constituents serve to diagnose chronic nephritis. In hysteria and intermittent hydronephrosis the polyuria is inconstant, and a renal swelling may be felt in the latter. Examinations of the urine and the blood for sugar differentiate diabetes mellitus. The nicotine test may be used as a diagnostic procedure. Normally the inhalation of the smoke of 1 to 8 cigarettes, until there is severe malaise, giddiness, nausea or vomiting, causes an antidiuretic response owing to stimulation of the supraoptico-hypophyseal system and release of the antidiuretic hormone. In many cases of diabetes insipidus no such antidiuretic response is obtained. Fluid deprivation tests may also be employed which stimulate the osmoreceptors.

Course and Complications. The hereditary type often runs a prolonged course for many years. In other cases the course must vary with the cause. Complications include pulmonary tuberculosis and coma; the latter is the usual mode of termination.

Prognosis. This varies with the cause. In idiopathic cases life may be little, if at all, curtailed. Syphilitic cases may be cured by treatment. In malignant cases the disease is usually fatal within a year.

Treatment. In syphilitic cases iodides and penicillin should be given. A salt-poor diet may be given but the fluid intake should not be restricted. Posterior pituitary extract has an antidiuretic effect; 1 ml. (20 units) may be required two or three times a day intramuscularly or last thing at night, or 0.5 ml. of vasopressin, which is the active constituent. If intestinal colic ensues a nasal spray of synthetic lysine-vasopressin, 50 units/ml., can be used up each nostril several times a day.

A more prolonged effect, lasting for about 44 hours, is obtained by the subcutaneous injection of 1 to 1.5 ml. of Pitressin Tannate (5 pressor units in 1 ml. of peanut oil). This treatment may have to be continued indefinitely. Certain diuretic drugs, such as chlorothiazide and its analogues including hydroflumethiazide (Di-Ademil) and clorexolone (Nefrolan), exert an antidiuretic effect in diabetes insipidus. This is due to an action on the kidneys, whereby the urinary sodium excretion and osmolality are increased. The polyuria and polydypsia are largely abolished by giving the patient clorexolone 12.5 mg. tab. b.i.d. with potassium supplements of 40 m.Eq. per day. Thyroidectomy has proved successful in certain cases following encephalitis lethargica, and in those associated with thyrotoxicosis.

THE THYMUS GLAND

The thymus increases normally in size until puberty, after which it gradually atrophies. The thymus may hypertrophy if the adrenals atrophy, but it is very doubtful if it has an endocrine function. Its only known function is the production and possibly destruction of lymphocytes (see p. 658).

Status Lymphaticus

A condition characterised by enlargement of the thymus gland and lymphatic tissue generally. The symptoms include: Thymic asthma, due to pressure of the enlarged gland causing dyspnoea with stridor. This may be mistaken for croup due to laryngeal obstruction. Sudden death may occur during sleep or during the administration of an anaesthetic, possibly due to mechanical stimulation of the vagus. Enlargement of the thymus can be diagnosed by X-ray examination and treated by exposure to X-rays.

Thymic Tumours

These may be simple, such as a lipoma or fibroma; cystic, such as a dermoid; or malignant, such as a carcinoma or sarcoma. The tumour may also be due to Hodgkin's disease. The effects produced are mechanical, those of a superior mediastinal tumour. In myasthenia gravis small non-malignant, soft, encapsulated nodules are found in some cases. A thymic tumour may be shown by lateral tomography.

Treatment. The tumour may be removed in some cases by an operation involving splitting of the sternum. If this is not possible, X-rays should be used.

THE TESTES

The luteinising hormone of the anterior pituitary is concerned with the descent of the testicle and provokes the internal secretion of the interstitial cells, which is known as testosterone.

Testosterone can be synthesised and is inactive when given by mouth and has only a short effect if injected. Subcutaneous implanta-

tion of six 100 mg. pellets produces an effect which lasts about six months.

Methyltestosterone is effective when given by mouth, but on absorption from the intestine is chiefly destroyed before reaching the systemic circulation. It should be taken as a 10 or 25 mg. flat tablet, to be dissolved under the tongue or between the gum and cheek.

Testosterone propionate is a short-acting ester and should be given by intramuscular injection two or three times weekly in doses of 5 to 50 mg.

Long-acting esters have been prepared for intramuscular injection, such as testosterone cœnanthate and propionate (Primoteston Depot). 250 mg. are efficacious for 3 to 4 weeks.

The male sex hormones have three main actions: 1. *Development of secondary male sex characteristics.* They are used as replacement agents in hypogonadism due to primary testicular atrophy or to testicular atrophy due to mumps or injury. They are also of value in cases of eunuchoidism, or after castration, or with certain pituitary lesions, such as chromophobe adenoma. 2. *Anti-œstrogenic effect.* In certain functional menstrual disorders a daily oral dose of 10 mg. of methyltestosterone is of value. This is usually given for two weeks before menstruation is due. Nor-ethisterone (Primolut N), 5 mg. tab. once or twice a day, may be more effective. Both of these preparations may be used in cases of inoperable breast carcinoma, to try and arrest the primary growth and promote the formation of new bone in osseous metastases. With methyltestosterone large doses may be required and these may have a virilising effect. This is less likely to occur with Nor-ethisterone. 3. *Anabolic action.* Androgens such as norethandrole (Nilevar) 10 mg. tab. daily may be given to increase weight in very thin women, to lay down protein in skeletal muscles and in the matrix of bone. They are also used to relieve muscular weakness in men suffering from androgen deficiency and, given with œstrogen, they are used in the treatment of senile osteoporosis. For this Mixogen (ethinylœstradiol 0.0044 mg., and methyltestosterone 3.6 mg.) may be used in doses of 2 to 6 tabs. daily. The above account is largely based on the article by P. M. F. Bishop (B.M.J., 1960, i, 184).

THE OVARIES

Ovarian Hormones. As described above the ovary, when stimulated by the pituitary gonadotrophic hormones, secretes the œstrogenic hormone, œstradiol, and the active principle of the corpus luteum, progesterone. Œstradiol is concerned with the growth of breast duct tissue, and with the proliferative changes in the uterine wall which occur during the first half of the menstrual cycle. Progesterone causes premenstrual changes in the uterine mucosa, is responsible for the implantation of the ovum and placental formation, and growth of the alveolar breast tissue during pregnancy. Œstradiol, which is regarded as the primary hormone is not detectable in the urine. Instead, the structurally related but physiologically less active compounds,

œstrone and œstriol, are found. Urinary extracts do not contain measurable amounts of progestational substances. Progesterone cannot be isolated from late pregnancy urine or blood as such, but the biologically inactive reduction product, pregnonediol can be obtained. Synthetic œstrogenic analogues (such as stilbœstrol, hexœstrol, and dienœstrol) are available for clinical use. Progesterone is obtained from the corpora lutea of sows, or it can be synthesised.

Clinical Applications. Œstrogens are not of value in *primary amenorrhœa*. Menstruation can be postponed for social reasons by giving norethisterone, 5 mg. tab., t.i.d. from the 25th day of the cycle, onwards. *Premenstrual tension* can be relieved by an oral diuretic for a few days before a period, or by norethisterone, 5 mg. tab., b.i.d. for 7 days, beginning 10 days before the expected period. *Spasmodic dysmenorrhœa* may be assuaged by Enavid-E, 1 tab. from the 5th day, reckoning from the beginning of the period, for 20 days, for 3 cycles. *Menorrhagia* may be controlled by norethisterone, 5 mg. tab., t.i.d. from the 1st day of the cycle for 10 days for 3 cycles, and for *metrorrhagia*, if iron fails to cure, norethisterone, 5 mg. tab. should be given from the 5th to the 26th day. To stop bleeding urgently ethinylœstradiol, 0.05 mg. tab. should be given 4-hourly. *Suppression of lactation.* Stilbœstrol, 5 mg. tab., should be given 6-hourly for 6 days, and then reduced over 10 days. *Senile vaginitis and vulvitis.* Œstrogen pessaries or ointment, 0.1 mg./G. may be used. *Recurrent carcinoma of the breast and carcinoma of the prostate.* Stilbœstrol, 5 mg. tab., may be prescribed up to 6 or more in 24 hours.

Oral Contraceptives

There are several contraceptive tablets available such as Conavid, Enavid, Gynovlar 21, Norlestrin, Ovulen, Volidan, etc. They contain synthetic progestogens and œstrogens in varying proportions. The progestogens act by inhibiting ovulation, either by direct action on the ovary, or indirectly via the pituitary. They also interfere with the normal maturation of the endometrium and so implantation of the ovum is impaired, and they increase the thickness of the cervical mucus which mitigates against the entrance of spermatozoa. A small amount of œstrogens is included in the tablet to support the endometrium and to diminish the liability to "break-through" bleeding when the tablet is being taken. With the œstrogen a smaller amount of progestogen is required in the tablet.

Mode of Administration. One tablet is taken on the fifth day from the beginning of a period and then daily for 20 days. There is usually "withdrawal bleeding" within 3 or 4 days after stopping the tablets. The first day this occurs is taken as the first day of the period, and on day 5 the 20 day course is repeated, and so on. The course is therefore 20 days, but with some tablets the course is 21 days which makes it easier to remember. The tablets usually maintain a regular cycle, but "break through" bleeding may occur before the 20th day in the first course. If this bleeding recurs an examination should be made by uterine curettage to exclude carcinoma of the body of the uterus. After

discontinuing the contraceptives, pregnancy usually takes place if desired. When the tablets are taken regularly they are nearly 100% effective.

Side Effects. These include nausea, vomiting, headache, pigmentation of skin in areas exposed to sunlight, breast discomfort, depression, abdominal cramp and lethargy, but many women feel better when taking the tablets. Serious conditions have been reported such as thrombo-phlebitis, pulmonary embolus, coronary and cerebral artery thrombosis, jaundice, liver damage and a lowered carbohydrate tolerance. They should not therefore be given in diabetes. It is too early to say yet whether the contraceptives are carcinogenic, but the general impression is that there is no evidence to support this view.

INFANTILISM AND DWARFISM

Definition. Infantilism is a condition characterised by delay of adult development with deficiency of secondary sexual characteristics. There may be no abnormality of growth. In dwarfism the secondary sexual characteristics, mental and bodily, are present, but growth is stunted.

Infantilism

This may be due to : 1. *Deficiency of an internal secretion.* Thyroid deficiency as in cretinism, pituitary deficiency as in the Lorain type or Fröhlich's type of infantilism. An infarct in the anterior lobe of the pituitary will also cause progeria. Pancreatic deficiency as in pancreatic infantilism with inefficient fat digestion, renal deficiency as in renal infantilism associated with cardiorenal degeneration and dilatation of the bladder, ureters and pelvis of the kidneys, testicular and ovarian deficiency as in male and female eunuchoidism. 2. *Mongolism* (Down's syndrome). This may occur especially in the last born child in a large family, or if the mother is elderly. There is mental deficiency and the appearance of the child is characteristic. The palpebral opening slants downwards and inwards, the hands are broad, the index finger is short and the middle phalanx of the little finger is short and the finger is incurved. In about 27% of cases two creases only, instead of the normal three creases, are present on the little finger of one or both hands, the distal and medial creases being replaced by a crease between the distal and proximal interphalangeal joints (Penrose). The foot "grasp-reflex" is present in about 5% of cases. The tongue is often large, fissured and protrudes. The disposition is usually calm and affectionate. Enlargement of the thyroid gland and congenital heart disease may be present. The condition is incurable and not benefited by thyroid treatment. There appears to be a predisposition to the development of leukaemia in mongols. The chromosome abnormality is described below. 3. *Congenital aberrations and diseases* such as microcephaly, congenital heart disease, anangioplastic infantilism (the arteries being improperly developed), persistent thymus and congenital syphilis. 4. *Acquired disease and infections* such as extensive bronchiectasis, ankylostomiasis, malaria and alcoholism.

Dwarfism

This may be due to such conditions as congenital deficiency of the anterior pituitary growth hormone, rickets, renal dwarfism, spinal caries, osteogenesis imperfecta, achondroplasia, phocomelus (φώκη = a seal, μέλος = limb), hydrocephalus and microcephaly. Dwarfism due to deficiency of the growth hormone responds to treatment with human growth hormone.

Sex Determination

In some cases it is not possible to decide by clinical examination the true sex of the patient. Special methods have been evolved to determine the sex by microscopical examination of certain cells.

Nuclear sex determination. In 1949 it was noted that the nuclei in cells of females frequently contained a deeply-staining dot, close to the inner surface of the nuclear membrane, and that this is absent in male cells. For this test smears are made from the buccal mucous membrane and the dot is referred to as the sex chromatin. A chromatin-positive body indicates a female, and a chromatin-negative one a male.

In 1954 it was found that a drum-stick projection is present on a small number of nuclei of polymorphonuclear leucocytes in females, but never in males. The drum-stick is attached to the rest of the nucleus by a thin thread. In some cases it forms a sessile nodule on the nucleus.

Genetic sex determination. In 1956 it was shown that the normal number of human chromosomes is 46, and not 48 as previously thought. Forty-four of the chromosomes (22 pairs) are autosomes and non-sexual, and one pair is composed of sex chromosomes. These are alike in the female, they are called XX and are probably the seventh pair in order of size. They are metacentric which means that when the chromosomes split longitudinally the two chromatids thus formed remain attached at their centres. In the male the sex chromosomes are unlike and are called XY, the Y chromosome being smaller than the X. The Y chromosome is acrocentric, the two chromatids formed by splitting being attached at one end.

The chromatin dot in the tissue cells and the drum-stick projection on the polymorphonuclear nucleus are thought to be part of the XX chromosome. If the nuclear sex test is chromatin-positive, two X chromosomes are thought to be present. Chromosome studies are made on short term cultures of bone marrow cells.

Gonadal sex determination. Normally the cortex of the primitive gonad develops in the female into an ovary, and in the male the medulla develops into a testis. The gonads are responsible for the male or female development of the genital tract. There are two varieties of gonadal dysgenesis, Klinefelter's syndrome and Turner's syndrome. *Klinefelter's syndrome.* Here the patient is apparently a male. He has small testes which fail to mature, gynæcomastia and azoospermia. The nuclear sex chromatin test is positive and there are 47 chromosomes, owing to the presence of an extra X chromosome. The genetic constitution is XXY. *Turner's syndrome* (ovarian dysgenesis). The patient anatomically is

apparently a female, actually "she" is neither male nor female. The condition is characterised by dwarfism, webbing of the neck, sometimes coarctation of the aorta, red-green colour blindness in 8% of cases, a small uterus and failure of development of secondary sex characteristics at puberty. The ovarian stroma only occasionally shows germinal cells. The nuclear sex chromatin test is often negative and there is only one X chromosome and no Y chromosome. The genetic constitution is therefore XO.

In *Mongolism* the total number of chromosomes is 47, owing to the presence of a small extra acrocentric autosome, which is found in males and females. In *acute leukaemia* abnormal chromosome findings have been recorded in some cases.

In *Pseudo-hermaphroditism* the patient is regarded as being a male or female according to the gonad which is present and not according to the external genitalia which may be mixed male and female or of the sex opposite to that of the gonad. The nuclear sex determination tests afford good evidence of the type of gonad present. This is of some importance when plastic operations on the external genitalia are being considered to correct defects and make the patient a man or a woman. The sex in which the patient has been brought up—the *social sex*—does not necessarily agree with the nuclear sex, although it may accord with the anatomical sex, and this should be remembered when a plastic operation is contemplated.

In *True hermaphroditism* the gonad contains both testicular and ovarian tissues or one ovary and one testis are present. The external genitalia may be male or female. The nuclear sex determination test is chromatin-positive in many cases, but the frequency of occurrence of chromatin-positive findings and of drumsticks on the polymorpho-nuclear nuclei is within normal limits.

CHAPTER XIV

THE TROPICAL DISEASES

Malaria

Definition. A disease characterised by recurrent attacks of fever, due to infection with a specific protozoon.

Etiology. Malaria is due to infection with a protozoon, the *Plasmodium malariae*. Infection in man is caused by the bite of a female anopheline mosquito. The mosquitoes may fly normally 1 to 2 miles (1.6 to 3.2 km.), or as far as 10 miles (16 km.) if aided by the wind. Four types of plasmodium affect man, the *P. vivax* causing benign tertian malaria, the *P. malariae* causing quartan malaria, and the *P. falciparum* causing malignant tertian or subtertian malaria. The *P. ovale* is an uncommon parasite, so-called because the infected red cell becomes oval-shaped. It causes a tertian fever. The incidence of malaria in a locality can be gauged by the spleen index, *i.e.*, the proportion of the population with a palpable spleen, and the parasitic index as shown by blood slides. These run very closely parallel.

The Life Cycles of the Parasite. The mosquito forms the definitive host and man the intermediate host. There are two cycles, an asexual cycle in man and a sexual cycle in a mosquito.

The Asexual Cycle. The mosquito, when it bites man, introduces sporozoites. Within 2 hours the sporozoites disappear from the blood and settle in fixed tissue cells, particularly in the liver. They now pass through the schizont stage and merozoites are discharged into the blood. This is known as the pre-erythrocytic or PE phase of the parasite. After about a week these enter the red cells and become trophozoites. These grow and divide into segments forming schizonts (rosette), which rupture, liberating merozoites into the blood. The merozoites may now enter other red cells forming trophozoites, thus completing the asexual cycle. This constitutes the erythrocytic or E cycle of the parasite and causes the clinical attack of malaria. The majority of the parasites are in the capillaries of the spleen and bone marrow and not in the peripheral circulation.

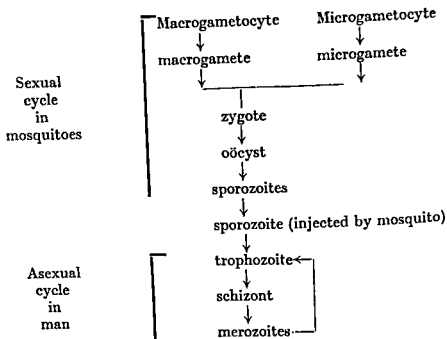
The Sexual Cycle. Some of the trophozoites may enlarge and become macro- or microgametocytes. If these remain in the blood they die without further development. If, however, a mosquito bites a man when the gametocytes are present, they are taken into the mosquito's stomach, where further development occurs. The macrogametocyte becomes a female gamete and the microgametocyte forms a microgamete. A microgamete enters and fertilises a macrogamete and a zygote results. This passes through the mucous membrane of the mosquito's stomach and forms an oöcyst. Numerous sporozoites develop in this cyst, which finally ruptures into the abdominal cavity, and the sporozoites pass to the salivary glands of the mosquito, and are injected into man by the

mosquito's bite. In *P. falciparum* infections the PE phase is thought to disappear soon after the E cycle is completed. Relapses are due to E forms persisting in the blood. In *P. vivax*, *P. malariae* and *P. ovale* infections the infecting agent remains in the liver as the exo-erythrocytic or EE phase, and relapses are probably due to merozoites liberated from this source.

These stages can be represented diagrammatically as shown below.

The main distinguishing features between the types of parasite are as follows :

Plasmodium Vivax. This causes benign tertian malaria. The duration of the asexual cycle in man is 48 hours. The schizont is like a



rosette with about 18 merozoites. Schüffner's dots (deeply staining) are seen inside some of the red cells, which are enlarged and pale. The gametocytes are large and round.

Plasmodium Malariae. This causes quartan malaria. The duration of the asexual cycle in man is 72 hours, the schizont is like a daisy-head, with 6 to 12 merozoites. The red cells are normal. The gametocytes are large and round.

Plasmodium Falciparum. This causes æstivo-autumnal or malignant tertian or subtertian malaria. The duration of the asexual cycle in man is probably 48 hours. Schizonts are rarely seen in the peripheral blood, but they contain about 20 irregularly arranged merozoites. The gametocytes are crescentic, the female ones having more pointed ends than the male. *Predisposing causes* : 1. Locality : Malaria is rife in the tropics, especially in India, Africa and America. It also occurs in Southern Europe. 2. Temperature : A mean temperature of 60° F.

(15.5° C.) for at least 2 weeks is necessary for the development of the protozoon in the mosquito. Stagnant water favours breeding of the mosquitoes. 3. Season and rainfall: The effect of these upon the incidence of malaria varies in different localities. 4. Age: Children are especially susceptible, but all ages may be affected.

Pathology. The spleen becomes enlarged and very hard in chronic cases (ague cake). In acute cases it is soft and swollen. The liver may be enlarged and dark red. The brain may be dark slate-coloured. Parasites and pigment may be found in the vessels in various organs, such as the spleen, kidneys and brain.

Clinical Findings. The symptoms in the benign tertian and quartan types of malaria, apart from the time intervals of the fever, are usually indistinguishable. The patient complains of periodical attacks, beginning generally about noon or later, of malaise, shivering, headache and perhaps nausea. He feels cold all over and may vomit. After a varying period of about 2 hours the skin becomes hot and flushed, and the headache is more intense. This phase persists for 2 or 3 hours, and is then followed by sweating and marked relief from the discomforts.

On Examination: During the initial cold stage the skin is blanched, but the body temperature rises to about 102° F. or 104° F. (38.9° or 40° C.), and the pulse is frequent. The fever is thought to correspond with the liberation of the spores in the blood, perhaps due to freeing of their toxins, but there must be a threshold value, a definite amount of toxin being required in any individual to produce a rise of temperature. Thus patients may have schizonts in the peripheral blood without any fever, and again there may be fever without schizonts being found, although they are probably present deeper in the body. In the hot stage the temperature begins to fall, and in the sweating stage it reaches normal or subnormal. The whole attack lasts about 12 hours.

In the benign tertian infection the pyrexial attacks follow each other every third day; in the quartan every fourth day (regularly intermittent fever). Daily (quotidian) attacks may be due to a double infection with benign tertian, or to a threefold infection with quartan malaria, or in some cases to malignant infection. A mixed infection may cause irregular attacks of fever.

In malignant (subtertian) malaria attacks are liable to occur in the summer or autumn in temperate zones, but in the tropics this seasonal incidence does not prevail. In the less severe types the attacks may recur daily or every other day, or at irregular intervals. Frequently there are no rigors, but the fever may last for 24 hours or longer. Specially severe variations include (a) Cerebral malaria, in which the patient rapidly becomes unconscious with hyperpyrexia, the temperature being over 107° F. (41.6° C.). In other instances there may be convulsions, paralysis or meningitic symptoms. (b) Algid type. The skin remains cold, and the body temperature may be subnormal or raised above the normal. There is great collapse and weakness. In some cases there is vomiting or diarrhoea, or hæmorrhages into the skin and various organs. (c) A bilious remittent fever. The characteristic features are the continuous temperature, jaundice and bilious vomiting. There is usually

severe epigastric pain. In the typhoid type the patient is more ill, the tongue is dry and delirium present. Blackwater fever is probably a variety of malignant malaria.

The spleen is usually palpable during the paroxysms, and in persistent cases remains so between the attacks, eventually becoming hard. It may reach to the umbilicus. The blood: When the temperature rises a film should be made, and stained for malarial parasites. Examination between the attacks usually yields negative results. In chronic cases a hæmolytic anæmia develops, and the large mononuclears may increase up to 20%. A positive Wassermann reaction may be obtained after the attack, but it is not universally accepted that this is due to the malaria. An indirect van den Bergh reaction is present in a large proportion of uncomplicated cases of subtertian malaria. The urine: Protein is present in a few cases and hæmoglobinuria is the characteristic feature of blackwater fever.

Differential Diagnosis. In a malarial country malaria is the cause of the majority of feverish attacks, but when the patient has resided out of a malarial district for several years the infection dies out. Malaria must be diagnosed from other conditions, such as kala-azar, tuberculosis, amœbic hepatitis, typhoid fever, sunstroke, meningitis, cholera, dysentery, and pyæmic infections causing rigors. The diagnosis rests upon: (a) Finding the parasite in the blood. Prophylactic doses of antimalarial drugs may obscure the diagnosis, as then no parasites are likely to be present in the peripheral blood. (b) The response to anti-malarial drugs. If the temperature does not fall after their adequate administration, the pyrexia is almost certainly not due to malaria. (c) The presence of a leucocytosis is also evidence against malaria. (d) Herpes labialis is frequently noted in an attack of malaria.

Course and Complications. The course depends largely upon the treatment, the attacks in the benign tertian and quartan varieties are usually readily controlled, but there is more difficulty with the malignant type. In certain localities blackwater fever is liable to ensue in patients suffering from chronic malaria or in those who have been improperly treated. Relapses, where fresh infection is impossible, may occur at considerable intervals after the last infection, and may be due to the schizonts lurking in the internal organs, or being present in too small numbers in the peripheral blood to be detected. Malarial cachexia is a troublesome feature of repeated attacks. Complications include: Bronchitis, labial herpes, neuralgia, neuritis, asthma, glycosuria, and pneumonia. Pulmonary tuberculosis may develop as a sequela. Blackwater fever is probably a complication of malignant malaria.

Prognosis. A favourable prognosis depends largely on early diagnosis and adequate treatment. The outlook is usually very grave in the cerebral and algid types of malignant malaria. Death is most often due to cerebral malaria.

Treatment. *Prophylactic.* This is concerned with: (a) Elimination of the breeding grounds of the mosquitoes. This is best effected by drainage and by sprinkling stagnant pools with some substance to

destroy the larvæ of the mosquitoes. D.D.T. powder, sprayed from aeroplanes, is effective, for 1/10 lb. per acre (11.2 mg./sq. metre) on water will destroy all mosquito larvæ. (b) Destruction of mosquitoes in houses or cattle-sheds during the winter. (c) Prevention of mosquito bites by the use of electric fans, sleeping nets and protection of the ankles during the evening or early morning by two pairs of socks or Wellington boots. Dimethyl-phthalate may be applied as an insect repellent, in the form of a liquid, cream or lotion, to the skin or clothing. (d) The prevention of infection in non-immunes, *i.e.*, those who go to an endemic area and who have not previously suffered from malaria, is a matter of some importance. The drugs most often used are chloroquine (Aralen), proguanil (Paludrine) and pyrimethamine (Daraprim). Mepacrine (Atebrin) and quinine are not so often used.

The mosquitoes may become resistant to pesticides and the malarial parasites to synthetic drugs, but they do not become resistant to quinine which remains a valuable sheet anchor in treatment.

Chloroquine is given in doses of 2 tabs. (= 300 mg. base) weekly; proguanil 1 tab., 100 mg., daily, mepacrine 1 tab., 100 mg. daily and pyrimethamine 25 mg. weekly for an adult, with smaller doses for children. Such prophylactic treatment should be begun 2 weeks before entering a malarial country and continued for 4 weeks after leaving the endemic area. A repository drug, Camolar, 5 mg. per kg. body weight, injected intramuscularly, has been shown to give protection for several months against *P. vivax* and *P. falciparum*.

Causal prophylaxis, *i.e.*, destruction of the parasite before it enters the red cell, can probably only be effected in *P. falciparum* infections. This is achieved by the use of proguanil (Paludrine) or of pyrimethamine (Daraprim), 1 tab. 25 mg. weekly. In the other varieties of infection prophylaxis is effected by suppression of the parasite in the blood. Relapses are therefore liable to occur for a time after cessation of treatment.

Curative. The patient should go to bed and be kept warm with blankets and hot bottles during the cold stage. The treatment varies with the type of infection present. For *P. falciparum* infections chloroquine or amodiaquine may be used. In a severe case chloroquine, 200 mg. base, in 5 ml. ampoule, is given intravenously. The contents are injected, in 10 ml. pyrogen-free sterile distilled water, very slowly intravenously. The dose can be repeated after 8 hours, up to 3 doses in 24 hours. It is not likely to produce blackwater fever. In less severe cases it is given by mouth in the following dosage: 4 tabs. (= 600 mg. base), followed 6 hours later by 2 tabs. On the next 3 days 2 tabs. The dose of amodiaquine (Camoquin) is 3 tabs. (= 600 mg. base) the first day, then 2 tabs. daily for 2 days. Alternatively, in a very severe case an intravenous injection may be given very slowly of quinine dihydrochlorid. 10 gr. (0.6 G.) dissolved in 10 to 15 ml. of sterile pyrogen-free water or well diluted in normal or dextrose saline.

The treatment of an acute attack of *P. vivax*, *P. malaria* or *P. ovale* infections consists in the eradication of the E (erythrocytic) forms of the parasites by chloroquine or amodiaquine, as for *P. falciparum* infections.

followed by attempts to get rid of the EE (exo-erythrocytic) forms by the use of one of the 8-amino-quinolines, such as primaquine which is said to be less toxic than pamaquine. The tablet of primaquine contains 7.5 mg. of the base and is given b.i.d. for 10 days.

Blackwater Fever

(Malarial Hæmoglobinuria)

Definition. A complication of malaria, characterised by hæmoglobinuria.

Etiology. Blackwater fever is usually considered to result from chronic infection with subtertian malaria. A chill, fatigue, or a dose of quinine, may precipitate an attack. Since quinine has been largely replaced by more efficient antimalarial drugs, blackwater fever is less often met with. *Predisposing causes:* 1. *Locality:* Districts where the incidence of subtertian malaria is high and the disease is endemic. It is thus especially prevalent in tropical Africa and in certain parts of India, etc. It occurs in England in patients who have returned after contracting subtertian malaria abroad. 2. *Nationality:* Europeans are more prone than natives. 3. *Repeated attacks of malaria:* The patient has usually lived over 6 months in the tropical country. 4. *A previous attack of blackwater fever.*

Pathology. The kidneys are enlarged and very congested. The renal tubules are obstructed with *débris*. The spleen and liver are enlarged, soft and pigmented. The brain and bone-marrow may be pigmented and the heart show fatty changes. The hæmolysis is believed to occur in the general circulation and not in the kidneys.

Clinical Findings. The patient is usually an adult European, who has been in a malarial country for over 6 months and who gives a history of repeated attacks of malaria for which he takes quinine. The onset is generally sudden, with a rigor; the urine is then noticed to be red, and there may be some frequency. Feverish symptoms, such as malaise, thirst, headache and loss of appetite, are complained of. There may be severe pain in the epigastrium or loins, with nausea, or vomiting of bile-stained fluid. Hiccough is a symptom in very severe cases.

On Examination: The patient is often jaundiced and the temperature is raised to 102° F. (38.9° C.) or over. The spleen and liver are palpable and tenderness may be elicited over them; in the epigastrium or renal areas. The urine: In some cases there is polyuria, in others oliguria or anuria. The urine varies in colour from almost black to pale red. A dark deposit settles on standing. The specific gravity is raised, and the reaction is acid. Protein is present in considerable quantities. The red colour is due to blood, Met. Hb being present and Oxy. Hb in the severe cases. The deposit consists of blood and granular casts, epithelial cells and a few red cells. The blood: There is a hæmolytic anæmia of varying degree. The red cells may be diminished by 50% within 24 hours and may show ghost forms and punctate basophilia. The fragility of the red cells is normal. The white cells: The large mononuclears may show an increase

up to 10% or more. The indirect van den Bergh reaction is positive and in severe cases the direct reaction is also positive. The blood urea is raised. Oxyhæmoglobin and methæmalbumin are present in the plasma.

Differential Diagnosis. The jaundice, temperature and bilious vomiting with dark urine are suggestive of yellow fever. In yellow fever there is hæmatemesis and the urine contains bile. Other causes of hæmoglobinuria rarely require elimination. There is usually no difficulty in diagnosis.

Course and Complications. The hæmoglobinuria persists for a few hours or days, and relapses are not infrequent. The temperature falls to normal when the urine clears. Complications include: Suppression of urine and hyperpyrexia. Cholelithiasis may ensue as a sequela.

Prognosis. There are many mild cases which recover, but the outlook is very grave in any severe case.

Treatment. Prophylactic. In districts where blackwater fever is endemic, every attack of malignant tertian malaria should be adequately treated with chloroquine (Aralen) or amodiaquine (Camoquin) in doses given on p. 785.

Curative. The patient must be put to bed and kept lying down at absolute rest. He should be given fluids containing dextrose, the amount of urine passed must be measured and charted daily, and when diuresis occurs the volume of ingested fluid can be increased. The intake of fluid should not exceed the output from the various sources, such as vomit, sweat, urine and faeces, except in very hot countries. An alkaline mixture containing Sod. bicarb. 30 gr. (2 G.), sod. citrat. 20 gr. (1·2 G.), sp. chlorof. 7 m. (0·45 ml.), aq. menth. pip. dest. ad 1 fl. oz. (30 ml.) should be given six-hourly or four-hourly. The value of endeavouring to keep the urine alkaline has been disputed. In some cases, despite large doses, the urine remains acid. If vomiting prevents this, drip rectal salines, containing sod. bicarb. 120 gr. (8 G.) to 1 pint (600 ml.), should be given. Oliguria is considered to be due to glomerular failure and renal anoxia. If there is oliguria hot applications, such as water bottles, should be applied to the loins. An intravenous injection of 1 pint (600 ml.) of 5% dextrose in normal saline or of 2% sodium bicarbonate in normal saline may prove helpful. If vomiting prevents the taking of sufficient fluid, rectal injections of 4 to 8 fl. oz. (120 to 240 ml.) of normal saline containing 5% dextrose should be given every 4 to 6 hours. To try and prevent anuria prednisone should be given in doses of 10 to 20 mg. q.i.d. If anuria develops a continuous intragastric drip (see p. 490) may be used, with a greater fluid intake in a tropical country. A drip blood transfusion of 500 to 1,000 ml. should be given to patients with polyuria. Careful cross grouping is necessary to prevent hæmolytic reactions. For peripheral circulatory failure, treatment consists of warmth, the intramuscular injection of 1 ml. of Pitressin and the oral administration of ephedrine hydrochlor. $\frac{1}{2}$ gr. (30 mg.) repeated six-hourly or an intravenous drip may be given of 1-noradrenaline (see p. 251). It is usually considered inadvisable to prescribe any antimalarial drug during the acute stages of the illness and the anæmia

response to emetine treatment and finding cysts in the faeces establish the diagnosis. Pulmonary amœbiasis is most likely to be mistaken for pulmonary tuberculosis owing to the hæmoptysis, or for other forms of lung abscess. Here again the condition is often met with apart from any definite history of dysentery, and the diagnosis is established by the response to emetine treatment. A hard tumour, called an amœboma, in the large intestine may be mistaken for carcinoma.

Course and Complications. The course depends entirely on the treatment; adequate early treatment cuts short the disease and prevents relapses; some chronic and neglected cases are very difficult to cure. Complications include: Intestinal perforation, intestinal stenosis with partial obstruction, and gangrene; hepatic abscess, which may rupture into various sites; cholecystitis; pulmonary abscess; cerebral abscess; thrombosis of veins in the legs or pelvis. Abdominal adhesions are liable to follow a liver abscess which reaches the surface.

Prognosis. This is good in uncomplicated cases properly treated. Brain abscess is probably always fatal. Liver abscess, with modern treatment, has a low mortality. Multiple liver abscesses are more grave. Lung abscesses usually recover with treatment.

Treatment. Prophylactic. Water and raw food should be protected from house flies. Cyst-passers should not be employed as cooks. Cyst-carriers may be treated with Diodoquin in tablet form, 650 mg., 1 tablet every 8 hours for 2 weeks.

Curative. The patient with acute dysentery should be kept warm in bed. The diet should be restricted to albumin water, milk and dextrose orangeade in quantities of 2 to 3 pints (1.2 to 1.8 litre) a day. Emetine hydrochloride 1 gr. (60 mg.) in 1 ml. of distilled water should be injected subcutaneously or intramuscularly every evening for 5 to 10 doses. The patient must stay in bed during this time, owing to the cardiac depressant effect of the emetine. The diarrhoea usually ceases after 4 or 5 days. A sterilising course of treatment should now be given, as is also used for chronic cases. Emetine bismuth iodide (E.B.I.) by mouth usually proves very efficacious. E.B.I. 3 gr. (0.2 G.) is given in a hard gelatin capsule at night 3½ hours after the last meal. To prevent nausea and vomiting phenobarbitone 1½ gr. (90 mg.) should be administered by mouth 1 hour before the E.B.I. This is given for 12 doses. Primary pulmonary amœbiasis usually responds quickly if treated in the same way. Favourable results have been reported by treating amœbic colitis with oxytetracycline (Terramycin) 500 mg. every 6 hours for 2 weeks if there is a superadded bacterial infection. After 2 weeks' interval the course is repeated. During convalescence the patient should avoid red meat, spices, rich food, cheese and potatoes.

Amœbic abscess of the liver is best treated by aspiration of the pus and a course of 12 subcutaneous injections of emetine 1 gr. (60 mg.) or by the administration of chloroquine (Aralen) 4 tabs. (= 600 mg. base) once daily for 2 days, and then 3 tabs. once a day for 21 days. This may be combined with emetine treatment. Open operation should not be performed unless the pus is found to be secondarily infected, or the

abscess is in a position inaccessible for aspiration. The mortality has been much lowered by closed aspiration treatment. Emetine hydrochloride 1 gr. (60 mg.) in 1 fl. oz. (30 ml.) distilled water may be injected into the abscess cavity after aspiration.

Cholera

Definition. A disease due to a specific bacillus, characterised by severe watery evacuations, muscular cramps and collapse.

Etiology. The cause is the *Vibrio cholerae* (comma bacillus). It is conveyed from man to man by means of infected water and food, such as melons, milk, etc. The vibrios pass out in the faeces and the water is thus contaminated. Fingers and flies may also convey the vibrios. Carriers occur, but they are usually convalescent patients who remain carriers for a few weeks or months only. The disease was disseminated largely by pilgrims or traders. The El Tor vibrio causes paracholera. **Predisposing causes:** 1. Locality: Cholera occurs chiefly in India, endemically and epidemically. Epidemics have arisen in Europe and America. 2. Season and climate: The incidence is favoured by a high absolute humidity of the air (over 0.400).

Pathology. At autopsy the body is wasted and dehydrated; the muscles are dark. The chief lesion is in the ileum, where the mucous membrane is reddened and the contents may be of the "rice-water" character; white flakes of cellular debris in a clear fluid. The spleen is often small, the kidneys may show areas of focal necrosis and hyaline changes in the convoluted tubules.

Cholera vibrios are usually confined to the intestine, but some may be found in the gall-bladder; more rarely there is a septicæmia, and they are present in the spleen and urine.

Incubation Period. This varies from a few hours to 5 or 6 days.

Clinical Findings. Cholera may begin quite suddenly, or there may be a few days of diarrhœa, not of a typical choleraic nature at the onset. The patient complains of very severe diarrhœa, in which, after the bowel has been emptied of fecal matter, the evacuations consist mainly of water. There is marked prostration, and severe cramps in the legs and abdomen, which may cause muscle rupture. Vomiting of watery fluid adds to the patient's misery, and there is intense thirst.

On Examination: In this algid stage the skin is cold and clammy, and has lost its elasticity, the patient is cyanosed, the eyes are sunken, the respirations and pulse rate are rapid, and the voice is feeble. The axillary temperature is normal or subnormal, but in the rectum the temperature is slightly raised. The stools are of a "rice-water" character (see above) and contain cholera vibrios. Bacteriophage is present in stools of patients who do well, and not present in fatal cases. The urine becomes very scanty, with a high specific gravity and protein is often present. The blood pressure falls below 100 mm. Hg. syst. The blood is "sticky" from concentration, the Hb. percentage rises, and the red cells number over 5,000,000 per c.mm. There is a leucocytosis of 20,000 to 50,000 per c.mm. The specific gravity of the blood rises from

the normal of 1.056 to 1.061, if 1 pint (600 ml.) of fluid has been drained away from the blood, and to 1.065 with a loss of 5 pints (3 litres). The blood culture is usually sterile, but a positive agglutination of dead cholera vibrios by the serum is found after the eighth to tenth days. The patient may rapidly die, or in a few days pass into the reaction stage. The body temperature rises, the skin becomes warm, the blood pressure rises, the pulse slows, and the output of urine increases; the watery vomit and stools cease. An irregular type of fever may now ensue with delirium and coma, called cholera-typhoid, or the temperature may rapidly settle as the patient's condition improves.

Varieties. 1. *Cholera sicca*: The patient rapidly dies, the bowels contain much fluid, but no "rice-water" stools are passed.

2. *Ambulatory*: Here the diarrhoea is not very severe, the constitutional disturbance is comparatively mild and there are no cramps.

Differential Diagnosis. There is little difficulty in an epidemic, and the diagnosis is made by the naked eye appearance of the "rice-water" stools when they are placed in a test tube and by an examination for vibrios. Other causes of acute gastro-enteritis must be excluded, such as food poisoning, and in England cholera nostras or summer diarrhoea. In tropical countries algid malaria is excluded by a blood film.

Course and Complications. The severe forms of cholera take a very rapid course; in less grave infections the course is more prolonged and relapses may occur during convalescence, with return of the diarrhoea. Complications include: Bronchopneumonia, parotitis, renal failure, uræmia and hyperpyrexia.

Prognosis. The mortality has been lowered by modern treatment to an average of about 20 per cent. In any epidemic the case virulence becomes less severe towards its close. The amount of fluid lost from the blood (as judged by the specific gravity) is a guide to the severity of the case.

Treatment. Prophylactic. In an epidemic, protection is afforded by boiling all water and milk, eating only cooked foods, avoiding all foods liable to cause diarrhoea, and by the isolation of contacts. Further, at any time vaccination will afford considerable protection for a short time. The anti-cholera vaccine contains 8,000 million dead vibrios in 1 ml.; the initial dose is 0.5 ml. followed by 1 ml. 10 days later. Immunity is established in 7 days. The validity of the certificate extends for 6 months. Children under 1 year should not be vaccinated; between the age of 1 and 5 years the dose is 0.25 ml. followed by 0.5 ml.

Curative. At the onset of the diarrhoea the patient should be kept warm in bed. The fæces and urine should be received in disinfectant as for typhoid fever. Morphine and opium should never be used. The patient should drink water, albumin or dextrose water, in small quantities frequently, taking as much as he can. Vomiting may be checked by giving tab. cocain. $\frac{1}{20}$ gr. (3 mg.) by mouth, repeated in half an hour if necessary. The most important part of the treatment is the administration of fluid and electrolytes. First, non-pyrogenic isotonic saline is injected intravenously, followed by a bicarbonate-saline-potassium mixture containing 5 G. sodium chloride, 4 G. sodium bicarbonate and

1 to 2 G. potassium chloride per litre. Care must be taken not to produce pulmonary œdema. The intravenous injection of tetracycline aids the elimination of the vibrios and shortens the duration of the diarrhoea. The dose is 100 mg. intravenously 6-hourly for 24 hours, and then 500 mg. by mouth for 4 days. During convalescence the diet must be very cautiously increased with diluted citrated milk, milk jellies, custards, etc.

Sprue

(*Psilosis*)

Definition. A disease characterised by emaciation, sore tongue, and diarrhoea.

Etiology. The cause is unknown. Sprue may be due to : 1. Damage to the villi of the small intestine, preventing phosphorylation of fats, glucose and galactose, and diminished absorption of fats, sugars and vitamins. 2. Infection with yeasts, such as the *Monilia psilosis*, or with streptococci. These are probably secondary infections. 3. Deficiency of the vitamin B₁₂ and folic acid in the food. *Predisposing causes:* 1. Locality: Especially China, Malaysia, India, Ceylon, the East and West Indies, and the southern states of N. America. Sprue may occur in certain houses. 2. Race: Europeans are liable to sprue in endemic zones and also may develop it several years after returning home. 3. Age and sex: Chiefly adults and slightly more common in women.

Pathology. The wall of the small intestine is very thin, and the mucous membrane is atrophied. Small ulcers may form and perforate. The large intestine may be similarly affected. The heart, liver and spleen are atrophied and the bone marrow shows megaloblastic hyperplasia. The atrophied intestinal mucous membrane interferes with absorption.

Clinical Findings. The onset is insidious with weakness, dyspepsia, a burning pain behind the sternum and flatulence causing abdominal distention. Looseness of the bowels is then noticed. The stools are frothy, copious and offensive. The patient loses weight progressively and complains of soreness of the tongue and mouth, and later soreness may also be referred to the œsophagus and rectum.

On Examination: The patient is very wasted when the disease is of some duration, and the skin is often dark, the areas of pigmentation often occurring on the face. The tongue in the early stages is red, and later small vesicles may form and the surface is smooth and shiny. In more chronic cases the tongue is shrunken and pale. Erosions may also be seen on the buccal mucous membrane. Skin changes also include follicular hyperkeratosis, due to deficiency of vitamin A, and parakeratosis from lack of vitamin B. The liver dulness is diminished. Signs of subacute combined degeneration of the cord are rarely found. A test meal often shows deficiency of hydrochloric acid or a histamine-resistant achlorhydria. The barium meal may show clumping of the barium in the jejunum, the so-called "moulage" sign. The stools are typically large, pale and frothy. The pallor of the stool is not due to the excess of fat, but to alteration of stercobilin to leucobilin, the fat content may not be raised in a pale stool, and conversely a

coloured stool may contain an excess of fat. In some cases the stools are copious and watery. The total fat is usually increased to 50 or 80% (normal 20 to 80% of dried faeces), there being an increase of the split fat. The blood shows often a megaloblastic anaemia with a high colour index. In some cases there is an iron deficiency, as shown by a low mean corpuscular haemoglobin concentration. The leucocytes are often below normal in number with a relative lymphocytosis. Lack of absorption of vitamin K may cause a hypoprothrombinemia. The dextrose tolerance test often shows a low curve due to deficiency of absorption, and the blood calcium may be below normal. Sternal puncture shows changes similar to those found in pernicious anaemia (see p. 524).

Differential Diagnosis. The history of residence abroad and the clinical picture is characteristic. Coeliac disease in adults (see p. 64) closely resembles sprue. In chronic pancreatitis there is an excess of unsplit fat. In some cases the blood count may closely resemble that of pernicious anaemia.

"Hill diarrhoea" is liable to occur, especially in India at an altitude of over 6,000 feet (1,800 metres). It resembles sprue with the pale, frothy stools occurring in the morning, and may develop into true sprue.

Course and Complications. The course is usually chronic, but acute relapses may occur, with the passage of 15 to 20 stools a day. Haematemesis or tetany may occur as complications.

Prognosis. Death may occur within a year if the disease is not treated, and in any case the prognosis is bad in patients past middle age.

Treatment. The patient must be put to bed and kept there for at least 6 weeks. The diet consists of milk, Benger's food or Yoghurt given in two-hourly feeds, beginning with 3 pints (1.8 litre) of milk in the 24 hours and increasing gradually to 5 pints (3 litres). It should be sipped very slowly. Sprulac is rich in protein and poor in fat, and is of value as an alternative to a milk diet. It is dissolved in water according to the directions, and six feeds are given in the 24 hours at intervals of 2 hours, the total quantity taken being gradually increased from two to six pints (1.2 to 3.6 litres). If milk food disagrees raw meat juice or 2 oz. (60 G.) feeds of lightly cooked minced steak may be given. The meat feeds are increased up to 1 to 2 lbs. (480 to 960 G.) daily. The motions should become formed after a few days' treatment. If constipation develops liquid paraffin should be given as required. After 6 weeks the diet should be gradually increased by adding fruit, such as strawberries, bananas, or apples 1 or 2 daily and gradually increasing to 1 lb. (480 G.) or more daily. A raw egg may be added to the milk, then 1 or 2 rusks, pounded fish, and, later, chicken are given. Bism. salicyl. 15 gr. (1 G.) t.d.s. two hours after meals helps to check loose motions. For the acute relapses, sulphaguanidine should be given in doses of 3.5 G. repeated every 4, 6, or 8 hours.

Prednisone in doses of one 5 mg. tab. q.i.d. for 2 to 3 weeks, and then gradually diminished to zero during the next 2 months, should be given to try to induce a remission. Vitamin B₁₂, in doses similar to those given for pernicious anaemia, is useful both to control the sprue and to cure the

anæmia. Folic acid may be given. The dose is 10 to 20 mg. daily by mouth, in the acute stage, followed by 2·5 to 10 mg. daily until cure is effected. The disadvantage of this treatment is that neurological complications may develop, and it should not be given if there is evidence of subacute combined degeneration or of neuritis. Tab. Fersolate 2 t.d.s. p.c. should be given if there is iron deficiency. If the anæmia is very severe blood transfusion is of great value. Nicotinic acid 100 mg. t.d.s. and riboflavin 3 mg. t.d.s. should be given for the stomatitis. Deficiency of ionised calcium is made good by calcium lactate 15 to 60 gr. (1 to 4 G.) t.d.s., together with Radiostoleum capsules 3 m. (0·2 ml.), t.d.s.

After each feed the mouth should be cleansed with an alkaline solution containing sod. bicarb. 60 gr. (4 G.) to 5 fl. oz. (120 ml.) of water. As soon as the patient is convalescent he should leave the affected area and not return.

Plague

(The Black Death)

Definition. A disease characterised by septicæmia, and frequently by enlargement of a group of lymph nodes, due to infection with a specific bacillus.

Etiology. The cause is the *Pasteurella pestis*. Rats suffer from plague, and bubonic plague is conveyed to man by the bite of the rat flea (especially the *Xenopsylla cheopis*). Direct droplet infection from man to man causes the spread of pneumonic plague. *Pre-disposing causes*: 1. Locality: Plague is endemic in parts of India, Indo-China, the East Indies, Siberia, North and East Africa, etc., and sporadic cases occur in Europe and in ports, such as London. In 1664-1665 the great epidemic occurred in London. 2. Climate and season: A mean temperature over 80° F. (26·6° C.) is unfavourable to plague. In temperate zones it occurs in the summer and autumn. 3. Hygienic conditions: Dirt and overcrowding favour its development. 4. Age and sex: No age or sex is exempt.

Pathology. The disease is a hæmorrhagic septicæmia. Post-mortem the body may appear livid (black death), owing to ecchymoses. The lymph nodes at various sites are enlarged, matted together and surrounded with a hæmorrhagic œdema. Serous membranes show ecchymoses and blood-stained effusions. The spleen is enlarged and soft; the liver is enlarged, due to cloudy swelling, and small abscesses may be present; the kidneys may show cloudy swelling; ulcers may be found in the colon. The lungs may show hæmorrhagic bronchopneumonic patches or lobar involvement. The causative organism may be isolated from the blood, lymph nodes, spleen, lungs, etc.

Incubation Period. 2 to 10 days.

Clinical Findings. In bubonic plague the patient is suddenly taken ill with malaise, shivering, pains in the back and legs, nausea, and vomiting. He becomes very weak, is mentally confused and the gait may be staggering. In a day or so he feels a painful swelling in a groin or elsewhere, owing to the bubo.

On Examination: The face is dusky or flushed, the conjunctivæ injected and the expression may be wild. The temperature is raised, usually over 102° F. (38·9° C.), and the pulse frequent. The primary bubo is generally in the groin, the lymph nodes being enlarged, tender, and the subcutaneous tissues over them feeling œdematous. Less often the primary lymph node enlargement occurs in the axilla or neck. Fluid obtained by lymph node puncture shows plague bacilli. The blood: There is a high leucocytosis, which may reach 80,000 per c.mm. The blood culture may show the *Past. pestis*. The urine often contains protein. The lymph nodes usually, but not invariably, suppurate in about 7 to 10 days. The temperature runs an irregular course, and in cases which recover it falls by lysis, when the lymph nodes, if they do not suppurate, diminish in size and often there is marked sweating. Skin lesions may occur, ecchymoses are common, but in addition there may be vesicles, pustules or areas of gangrene resembling carbuncles.

Varieties. 1. *Abortive plague (Pestis minor)*. Pyrexia may be slight or absent, and the enlarged lymph nodes are not very painful. Constitutional disturbance is slight and the patient remains ambulatory. The buboes may or may not suppurate.

2. *Pneumonic plague*. This may be primary or complicate bubonic plague. The signs and symptoms are pulmonary; there is marked dyspnoea, with cough and expectoration.

On Examination: The patient is dusky and cyanosed; râles may be heard scattered in the lungs, or areas of bronchial breathing with increased voice conduction. A pleural effusion often forms. The sputum is thin, watery and coloured pink with blood; it is not sticky and contains the *Past. pestis*.

3. *Septicæmic plague*. The patient usually dies before a bubo or bronchopneumonia has had time to be manifest.

4. *Intestinal plague*. This is an unusual variety, in which buboes do not form, but there is diarrhoea with blood and vomiting. Plague bacilli are found in the stools.

5. *Cerebral plague*. This is also a rare variety, characterised by convulsions and coma.

Differential Diagnosis. In an epidemic there is little difficulty in recognising plague. Sporadic cases may be confused with other forms of septicæmia, with typhoid fever, glandular fever, malaria (cerebral), or influenzal bronchopneumonia. The buboes must be distinguished from those due to lymphogranuloma venereum and tularemia. Diagnosis is established by finding the causative organism in the fluid from lymph node punctures, the blood, urine, fæces or sputum.

Course and Complications. The course of bubonic plague is as described above; the course may be rapidly fatal in the pneumonic, septicæmic or intestinal type, and this is the rule with cerebral plague. Complications include pneumonia in bubonic plague and severe hæmorrhage from erosion due to a sloughing bubo.

Prognosis. This has been considerably improved by the use of sulphonamide drugs and antibiotics. The mortality for the pneumonic and septicæmic varieties was formerly nearly 100%, the bubonic variety

proved fatal in about 80% of cases in natives and in about 80% of cases in Europeans.

Treatment. Prophylactic. This is chiefly concerned with the destruction of rats, and prevention of rats from entering houses or ships. Nurses should wear masks in caring for cases of pneumonic plague. In an epidemic a vaccine containing dead bacilli should be given, 1,000 millions for the first dose, and 2,000 millions 7 days later. It appears to exert partial protection for about 6 months.

Curative. The patient should be isolated for 4 weeks after the temperature is normal. He must be kept in bed and the temperature lowered by sponging if it rises over 106° F. (41° C.). The buboes should be fomented every 4 hours with 1 in 4,000 perchloride of mercury solution. When the buboes suppurate they should be opened. Sulphadiazine should be given, first 4 G., followed by 2 G. every 4 hours by day and night until the temperature is normal. In severe cases the dose should be doubled for the first 24 hours. When the temperature is normal 0.5 G. should be given every 4 hours for 14 days. The urine must be kept alkaline during the treatment and at least 4 pints (2.4 litres) of fluid taken every 24 hours. Streptomycin 0.5 G. may be given intramuscularly every 6 hours together with the sulphadiazine. In every case the urine and faeces should be disinfected as for typhoid fever.

Yellow Fever

Definition. An acute disease characterised by fever, jaundice, proteinuria, and hæmatemesis.

Etiology. Yellow fever is caused by an ultra-microscopic filterable virus. In the urban and rural types of the disease the virus is conveyed from man to man, or from animals such as monkeys to man, by a mosquito, the *Aedes ægypti* (*Stegomyia fasciata*). Patients are infective to mosquitoes for the first 4 days of their illness. The virus undergoes changes in the mosquito so that the latter does not become capable of infecting man for 10 to 12 days, but remains infective for its lifetime (about 2 months). Indian monkeys can be infected by the blood of a patient, but West African monkeys are less susceptible. The serum of a patient who has recovered from yellow fever protects a susceptible monkey from the virus. Jungle yellow fever occurs in Brazil, and man is infected by various forest mosquitoes. It is probable that monkeys and other forest animals act as reservoirs of infection for urban and jungle fever. **Predisposing causes:** 1. **Locality:** Yellow fever is endemic in West Africa and to a lesser degree in Brazil and Mexico. It was formerly very prevalent in Panama and Havana. 2. **Climate:** A mean average temperature of over 75° F. (23.9° C.) is necessary, and preferably a moist heat.

Pathology. The skin is very yellow. Hæmorrhages may be seen under the skin, in the muscles, stomach, intestines, pleura, meninges, kidneys and liver. The liver is soft and yellow and shows mid-zonal necrosis. The necrotic hyaline cells are known as Councilman bodies. Characteristic intranuclear inclusion bodies are seen in the liver cells.

The spleen appears normal. The kidneys show fatty changes, and casts may be found in the convoluted tubules.

Incubation Period. This is usually 3 to 6 days.

Clinical Findings. In the average severe type of the disease, the onset is sudden with a rigor and rise of temperature. The disease may fall into 3 stages. *The initial fever:* This lasts 3 or 4 days. The patient complains of severe headache, pains in the eyes, back and the calves of the legs. He may also have epigastric pain and vomiting, with constipation and insomnia. The virus can be isolated from the blood during the first 3 days of the fever.

On Examination: The face is flushed, the eyes bright, the skin dry, the pulse is somewhat rapid, about 120, and full. The urine diminishes and protein appears in increasing quantities. Jaundice appears about the third day. The vomit at this stage usually contains bile, but some blood may be present.

The period of remission: This lasts 2 or 3 days. There is some improvement in the general condition of the patient. The temperature falls and the pulse becomes slow. The tongue is furred but the tip and edges are clean. Convalescence may now ensue, but usually the patient passes into the *third stage, that of secondary fever.* The temperature rises again but the pulse rate remains slow (Faget's sign). The jaundice increases, the output of urine diminishes, much protein is present with granular casts, red blood cells, hæmoglobin and bile. "Black vomit" occurs, which is due to altered blood, and there may be diarrhoea with mælena. There are often hæmorrhages from the nose, gums and into the skin or from the uterus. Death may follow or the patient may gradually recover.

Varieties. 1. *Mild cases.* There may be only slight fever with headache and a little vomiting, and the patient is well in a few days. 2. *Malignant cases.* The temperature rapidly rises to over 106° F. (41° C.) with severe vomiting of blood, suppression of urine, coma and death.

Differential Diagnosis. The characteristic features of yellow fever are the jaundice, black vomit, massive proteinuria and slow pulse, with rising temperature. Mild cases may resemble dengue, but in the latter a rash is usually seen about the fifth day. Weil's disease may be hard to differentiate clinically, but it occurs in the absence of the mosquito which transmits yellow fever. The diagnosis of Weil's disease can be established by special laboratory tests. In malaria the spleen is usually enlarged and parasites are found in the blood.

Course and Complications. The course is as described above. Complications include: Abscesses in the skin, parotitis and occasionally relapse.

Prognosis. The average mortality varies between 20 and 50%. The outlook is unfavourable if the temperature rises to over 105° F. (40.5° C.) or if there is suppression of urine.

Treatment. *Prophylactic.* The disease has been stamped out in Panama and other places by mosquito destruction. Water tanks should be protected by fine metal gauze covers and certain small fish may also be placed in the water to eat up the mosquito larvæ. Mosquito

nets should be used at night. Mosquito control is not applicable for controlling jungle yellow fever. Prophylactic subcutaneous inoculation with 17 D chick embryo vaccine is now being practised with success, especially in the jungle type of fever. The dose is 0.5 ml. If a person requires yellow fever inoculation and small-pox vaccination in order to go abroad, and if he has not had small-pox vaccination previously, the primary small-pox vaccination should follow the yellow fever inoculation. Small-pox revaccination should be done 4 days after yellow fever inoculation or be given 7 days previously. Children under the age of 9 months should not be inoculated owing to the risk of encephalitis.

Curative. There is no specific cure known. The patient should be put to bed and kept warm and nursed under a mosquito net. Barley-water, alkalis and dextrose should be given by mouth in the form of dextrose orangeade or lemonade, 8 oz. (240 G.) of dextrose in 2 quarts (2.4 litres) of water, with the juice of 2 oranges or lemons, 3 to 4 pints (1.8 to 2.4 litres) daily and about 180 gr. (12 G.) of sodium bicarbonate in the 24 hours, sufficient to render the urine alkaline. The diet must not be increased during the period of remission except to give half-ounce (15 ml.) feeds of half strength milk and lime water. During convalescence only easily digested foods such as eggs in milk, soups, etc., should be given. Aperients should not be given by mouth after the onset of the illness; enemata should be used if required. The vomiting may be relieved by giving small drinks of iced champagne, or drop doses of liq. iodi mitis, 2 m. (0.12 ml.) in 1 fl. oz. (30 ml.) of water every hour, and by applying a mustard leaf over the epigastrium. If the dextrose cannot be taken by mouth rectal salines containing 5% dextrose may be given in doses of 6 to 8 fl. oz. (180 to 240 ml.) every 4 hours, or an intravenous injection of 10 fl. oz. (300 ml.) of normal saline containing 5% dextrose.

Leprosy

Definition. A disease characterised by the formation of specific infective granulomata, affecting chiefly the skin and subcutaneous tissues, mucous membranes and peripheral nerves.

Etiology. Leprosy is caused by the *Mycobacterium lepræ* (Hansen's bacillus) which has not yet been grown *in vitro*. It is thought that infection occurs in the majority of cases through the skin, less frequently by inhalation. No intermediate agent is known. The disease is thus probably spread by direct contact with an "open" case of leprosy, which may not have been diagnosed. Nodular cases are more infectious than nervous ones. Children born of lepers develop the disease in over 40% of cases, unless removed from their parents at birth; the disease is not hereditary. **Predisposing causes:** 1. Locality: Leprosy is endemic in various parts of the world, especially in India, China, Japan, tropical Africa, the East and West Indies; cases also occur in Europe, e.g., in Iceland, Norway, the Balkan States, and in Australia and America. In Great Britain in 1965 there were 310 registered cases. 2. Unhygienic home conditions and overcrowding. 3. Age: The greatest number of cases show themselves between the ages of 10 and 30 years.

Pathology. Granulomata are produced, containing "lepra cells,"

which may enclose lepra bacilli. The lesions are xanthoma-like in the lepromatous type, and sarcoid-like in the tuberculoid. The bacilli are found in the skin nodules and ulcers, in the nasal mucous membrane, in the liver and spleen, in the blood at times during life, and to a lesser extent in the nerves.

Incubation Period. In the majority of cases this is between 2 and 5 years.

Clinical Findings. The onset is insidious, and before any lesion is apparent there may be prodromal symptoms such as malaise, muscular pains, sweating, with some pyrexia lasting for 7 to 10 days at a time. There are three main types, which will be described separately:

1. *Lepromatous* (cutaneous). It is described as the malign form. The lepromin skin test is negative. When cases are carefully observed the initial lesion is often found to be solitary. It is situated usually on the buttocks or back, or extensor surface of limbs, or on the cheek. The lesion is a small red or reddish-brown, slightly raised shiny spot, about 0.5 cm. in diameter; further crops of spots appear with fever, and on fading they may leave some pigmentation. Some of the spots do not disappear but enlarge to form nodules, and these may ulcerate. Thickening of the skin over the eyebrows, ear lobes, nose and cheeks appears, which, together with the nodules, causes a leonine appearance; the outer part of the eyebrows falls out. Nodules may form on the conjunctiva, or in the mouth or larynx, and by ulceration cause blindness, hoarseness, etc. Necrosis of deeper tissues may occur with loss of fingers or toes. A slow symmetrical enlargement of nerves may occur.

2. *Tuberculoid* (neural, maculo-anæsthetic). This is described as the benign form. The lepromin skin test is positive. In this variety macules may be seen on the skin in the early stages, 1 or 2 inches (2.5 or 5 cm.) in diameter and of varying colour—pink, violet, brown or white. Sensation to light touch is often absent over these areas and they do not sweat. This may be demonstrated by heating the patient until he is sweating profusely, and then spraying him with quinizarin compound powder which when moist turns deep purple. The areas which sweat show up as dark patches (see Fig. 68). Thickening also occurs in nerves; the ulnar nerve becomes palpable at the elbow and other nerves such as the common peroneal or tibial may be felt. Disturbance of their function results in loss of sensation to heat, cold and pain, touch being present, and muscular wasting, especially of the small muscles of the hand, with a "claw" deformity. The most important sensory test is thermal anæsthesia. The lesions may result in a bilateral facial paralysis. Perforating ulcers occur in the feet.

3. *Indeterminate* (mixed). A case may begin with simple macular lesions as nodular leprosy and later nerve changes occur. Eventually lepromatous or tuberculoid lesions may develop.

Differential Diagnosis. Diagnosis is made in early cases by the appearance of the lesions, and by finding the lepra bacilli. This is effected by cutting out a small portion of the skin and making a smear on a slide from the subcutaneous tissue, or by examining juice obtained from a nodule, or by nasal scrapings. The organism must be

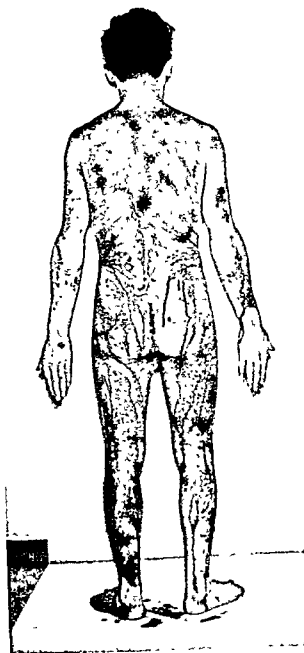


FIG 69. LEPRO. SWEATING TEST. THE AREAS WHICH SWLAT ARE SHOWN UP AS DARK PATCHES.

differentiated from the tubercle bacillus. The differential diagnosis includes other skin diseases such as erythema multiforme, lupus vulgaris, mycosis fungoides, syphilis, and nerve lesions such as syringomyelia. The histamine reaction consists in pricking a macule through a drop of 1/1,000 histamine phosphate. In leprosy a wheal forms, but there is no surrounding erythema; if it is injected just outside a macule the flare stops at the edge of the lesion.

Course and Complications. The course of an untreated lepromatous case is usually prolonged for 10 to 20 years or more. The disease passes through phases, such as the early quiescent stage, during which there is a slow multiplication of the bacilli with spread of local lesions; this is followed by a reactionary stage, with rapid proliferation of the bacilli and inflammation of the lesions and constitutional disturbance, and later there is a resolution stage in which the bacilli become granular and break down, and the local lesions tend to heal. The patient may then present marked deformities, but the disease is arrested. The most important complications are leprous iritis and iridocyclitis, also pulmonary tuberculosis and amyloid nephrosis. Tuberculoid cases tend to recover spontaneously in 2 to 3 years.

Prognosis. The use of the sulphone drugs has considerably improved the prognosis.

Treatment. Prophylactic. The incidence of leprosy can be materially lowered by: 1. Isolation of active cases. 2. Examination of home contacts every 6 months for 5 years. 3. Removal of the children of lepers at birth. 4. Treatment of early cases. 5. A large scale trial in Uganda of B.C.G. vaccination of children, from 1 to 15 years of age, indicates that it may prevent the development of tuberculoid leprosy. Further, Dapsone may protect persons exposed to leprosy.

Curative. Early cases, if not infective, can be treated in clinics; more advanced and infective cases should be isolated. A sulphone derivative, Dapsone (diaminodiphenylsulphone or DDS) should first be given. It is put up in 100 mg. tablets. The initial dose is 25 mg. by mouth, twice a week, increasing by 25 mg. every second week, to 300 mg. twice a week and continued indefinitely. If satisfactory progress is not made Thiambutosine (diaphenylthiourea or DPT) may be given. The tablet contains 500 mg., and 250 mg. are given by mouth daily, increasing by 250 mg. every second week, to 2 G. a day. After about 3 years drug resistance may occur and a return can then be made to DDS, beginning with 25 mg. twice weekly and increasing as above. Inunction with ditophal (Etisal), which has a very powerful action on *M. lepræ*, can be combined with the drugs mentioned above and drug resistance is then less likely to develop. It has a strong odour of garlic. If erythema nodosum leprosum develops during treatment it may be necessary to give up the sulphone treatment temporarily, and to give prednisone the first dose being 100 mg., decreasing daily to 75, 50, 25 and 12.5 mg. until the patient is comfortable, when the sulphone treatment can be given again. Iritis should be treated with 1% cortisone acetate drops, q.i.d., and with 1% atropine ointment. Despite treatment it appears that the lepra bacilli in the eyes may remain unaffected and blindness ensue.

Relapsing Fever

(Famine Fever. Tick Fever)

Definition. An intermittent fever due to a treponeme.

Etiology. Relapsing fever is caused by a treponeme, of which there are several varieties morphologically similar but which can be differentiated serologically. The average length of the treponeme is 18μ . The following are the main types: The *Treponema recurrentis* (*spirillum obermeieri*). This is conveyed to man by the bites of lice (*Pediculus vestimenti* and *capitis*). The treponemes may be excreted in the faeces of the louse or exuded from its body fluid if it is crushed on the skin, and they are inoculated usually by scratching. The treponemes are found in the blood of the patient during the febrile periods of the disease and lice become infective about 16 days after biting such a patient. The type of relapsing fever thus produced is met with chiefly in Eastern Europe and occasionally in North and West Africa, India, Ireland and America. Epidemics occur chiefly in the winter, especially amongst the poor. *Treponema duttoni*. This is conveyed by a tick (*Ornithodoros moubata*). These ticks infest houses and there is no seasonal incidence of the disease. The treponeme causes African tick fever, especially in Eastern and Central Africa and the Congo. Other varieties include: The *T. carteri* (India), *T. berberum* (N. Africa) conveyed by lice, and *T. persicum* (Persia) conveyed by ticks.

Pathology. Post-mortem the skin is often yellow and petechiae may be seen. The spleen is enlarged and may contain infarcts. Treponemes are found in the spleen, liver and bone marrow.

Incubation Period. 2 to 10 days.

Clinical Findings. The onset is usually sudden with shivering or a rigor, severe headache, pains in the eyes, legs and wrists, giddiness, nausea, vomiting and abdominal pain. There may also be epistaxis.

On Examination: The temperature rises rapidly to 104°F. (40°C.) or over and the pulse is frequent. There may be slight icterus of the conjunctivæ or definite jaundice, and in some cases a pink macular rash is seen on the neck, trunk and limbs with some petechial hæmorrhages. The spleen is enlarged and there may be tenderness over the liver. The blood: Treponemes are present. There is usually a leucocytosis and the Wassermann reaction may be positive. The adhesion test is also positive, specific immune serum causing the treponemes to adhere to platelets. The temperature remains irregularly raised for about 4 to 6 days and then falls by crisis with sweating. For the next week the patient feels well and is afebrile. A relapse occurs with a sudden rise of temperature and a return of symptoms lasting for about 2 days. Convalescence then generally ensues.

Varieties. African tick fever. The onset is usually more gradual, relapses more numerous and the pyrexial period is shorter, 1 to 2 days.

Differential Diagnosis. At the onset the disease may be mistaken for such conditions as influenza, malaria, dengue or typhus fever. Diagnosis is established by finding the treponemes in the blood.

Course and Complications. The course varies somewhat with the

different types. Complications include: Pneumonia, otitis, parotitis, nephritis, hæmatemesis and meningeal symptoms.

Prognosis. The disease is a serious one unless adequately treated. The African variety is usually more fatal than that caused by the *T. recurrentis*.

Treatment. Prophylactic. Lice in the clothes and head should be destroyed and native houses avoided which are infested by ticks.

Curative. The patient must be put to bed, kept on a fluid diet, the bowels opened with a saline, and an intravenous injection given of neoarsphenamine, 0.4 G. for a man, 0.8 G. for a woman, and 0.1 G. for a child. It is most effective if injected as the temperature is rising and should not be given immediately before the crisis is expected or severe collapse may result. One injection is usually sufficient to prevent relapses. If arsenic is contra-indicated owing to liver or kidney damage or a hæmorrhagic tendency, penicillin should be injected, 1,200,000 units of a procaine preparation every 12 hours for 4 days or tetracycline (Achromycin) is given by mouth, 0.5 G. 6 hourly for 5 days, then 1 G. b.i.d. for 5 days. In the tick-borne variety chlortetracycline (aureomycin) should be given, preferably in the non-febrile phase. The dose is 500 mg. twice a day for 2 days, then 250 mg. six-hourly to a total of 2 G., then 250 mg. six-hourly 2 days a week for 4 weeks. If the chlortetracycline is given during the febrile period the first dose should be 250 mg.

Scrub Typhus

Etiology. Scrub typhus is caused by the *Rickettsia tsutsugamushi* (*R. Orientalis*). The vector is a mite, the *Trombicula akamushi*, or other trombiculid mites. The mite only bites once, and, when thus infected with blood by biting an infected rodent, transmits the infection to its offspring, which now can infect man or an animal by its bite. The mites are most plentiful in damp vegetative areas. Rats and mice are the chief reservoirs of infection. Locality: South and East Asia, North Australia, and the Pacific Isles.

Pathology. The rickettsie multiply in the vascular endothelial cells. Deficient blood supply to the central nervous system is believed to account for the nervous, and for some of the circulatory disturbances.

Incubation Period. 7 to 21 days.

Clinical Findings. Scrub typhus was an important cause of sickness amongst troops in the 1939-45 war. Previously most of the endemic areas were not densely populated. The clinical features resemble those of louse-borne typhus fever. The onset is usually sudden with a chill, headache, and conjunctivitis. A primary eschar may be found in over 50% of cases, in the axilla, perineum, groin, or trunk, etc. There is generalised inflammation of lymph nodes towards the end of the first week. A maculo-papular rash is seen about the fourth day on the trunk, face, and proximal part of the limbs. Mental symptoms predominate during the second week, with a fall of blood pressure, and temporary deafness is not uncommon. The white cells in the blood are not generally

increased in number. In over 50% of cases the spleen is palpable. The temperature remains raised, with daily remissions, for about 2 weeks, and then falls by lysis. In scrub typhus the blood shows a modification of the Weil-Felix reaction. There is an agglutination of between 1/250 and 1/12,500 with *Proteus* OXK, and a feeble agglutination with OX19. *Proteus* OXK is a strain of *B. proteus*.

Differential Diagnosis. Malaria and dengue may be mistaken for scrub typhus, and malaria and scrub typhus may coexist. If the scar of the mite-bite is visible, the diagnosis can be made with more certainty at the onset. Flea-borne typhus may occur in the tropics, but louse-borne typhus is very rare there.

Course and Complications. Convalescence is usually slow, and the patient is likely to be off duty for 8 months or longer. Bronchitis and bronchopneumonia may occur as complications.

Prognosis. This has been much improved with antibiotic treatment.

Treatment. Prophylactic. Vaccine treatment has not proved successful. Clothing can be smeared with dimethyl-phthalate, which is a mite repellent. Camps should be placed in dry sites, and cleared of surrounding vegetations.

Curative. This is as for louse-borne typhus. Chloramphenicol (Chloromycetin), or chlortetracycline (Aureomycin), should be given in doses of 3 G., followed by 0.25 G. every 3 hours until the patient is afebrile. Penicillin may be of value in cases complicated by bronchopneumonia, given by intramuscular injection of 600,000 units of a procaine preparation every 12 hours for 7 to 10 days.

Trypanosomiasis

(Sleeping Sickness)

Definition. A disease characterised by enlargement of lymph nodes, followed by nervous changes and increasing torpor.

Etiology. Sleeping sickness is due to infection with a trypanosome, a flagellate protozoon. Man is infected by the bite of a tsetse fly. There are two main types: *T. gambiense* conveyed by the fly *glossina palpalis*, occurring in Uganda and the Congo. *T. rhodesiense*, conveyed by the fly *glossina morsitans*, occurring in Rhodesia, Nyasaland, Tanganyika, and Kenya. In tropical America there is a variety caused by the *T. cruzi*. The trypanosome undergoes a cycle of development in the tsetse fly and finally reaches the salivary glands to infect man when he is bitten. The fly may become infected by biting infected big game or man. Rarely the fly will bite a man and carry the infection direct to another man, without any intermediate cycle. **Predisposing causes:** 1. Locality: The disease is endemic in Equatorial Africa and America. *T. gambiense* infections occur near water, and *T. rhodesiense* in dry areas. 2. Age: Children and adults are infected. 3. Race: White and black races are equally susceptible

Pathology. Post-mortem there may be macroscopical evidence of meningitis, or changes only seen microscopically in the meninges over the brain and cord. Meningo-encephalitis and meningo-mylitis may

also occur with perivascular infiltration of lymphocytes. The changes resemble those found in dementia paralytica. The cerebrospinal fluid is under pressure and trypanosomes occur in it. Lymph nodes are enlarged.

Incubation Period. This is variable, 2 weeks or longer.

Clinical Findings. The illness begins insidiously, the patient feeling unwell owing to fever.

On Examination: During the first stage, the temperature is irregularly raised, the pulse is frequent, the posterior cervical lymph nodes are enlarged, there may be some œdema of the legs, and in white people a circinate erythema may be seen on the trunk. The blood: An excess of globulin may be demonstrated in the serum. Trypanosomes may be found in the deposit after centrifugalisation of the blood. The lymph nodes: Examination of the juice removed by puncture is more likely to show trypanosomes than is a blood film. The disease, if untreated, gradually passes after months or years into the second stage, characterised by changes in the cerebrospinal fluid. These include an excess of cells (50 or more per c.mm.) and excess of protein (over 40 mg./100 ml.). Trypanosomes are not often demonstrable. The patient becomes sluggish mentally and physically, he appears dejected, complains of pains in the body and loss of strength. The lymph nodes in various parts of the body become larger. He becomes more sleepy and dozes during the day. Tremors are seen in the tongue and muscles of the arms. The blood now shows an anæmia, and the large mononuclears may be increased to about 10% or over. In the third stage the patient is bed-ridden and finally becomes comatose.

Differential Diagnosis. Malaria is excluded by blood examination and the failure to respond to quinine or other antimalarial drugs. Finding the trypanosomes by lymph node puncture usually establishes the diagnosis in the early stages.

Course and Complications. The course of an untreated case is as described above; the disease can now usually be arrested by early treatment. Complications include: Septic rhinitis, otitis, terminal pneumonia and dysentery.

Prognosis. This depends largely on early treatment, but infections with the *T. rhodesiense* are more grave than those with the *T. gambiense*.

Treatment. Prophylactic. It has been suggested that big game should be destroyed in endemic zones, as they harbour the trypanosomes. They may, however, be beneficial, the tsetse flies biting them rather than man. The *glossina palpalis* lives in vegetation near water, and trees should be cleared in these zones. Travellers through such districts should wear gloves and helmets. Spread of the disease can be checked by the compulsory treatment of all natives affected. D.D.T. powder, sprayed from aeroplanes, as for the prophylaxis of malaria, is effective in destroying the tsetse fly. Pentamidine, 250 mg., injected intramuscularly will give protection for 3 to 6 months.

Curative. Early cases may be treated by the intravenous injection of suramin (Antrypol), first a test dose of 200 mg., followed a week later by 10 weekly injections of 1 G. The urine should be examined before

each injection for protein, blood and casts. If present the injection should not be given. When the central nervous system is involved suramin is not effective. Melarsopril (Mel B) may be given as it is less toxic than tryparsamide. The dose is 2 ml. of a 3.6% solution in propylene glycol intravenously on 3 days in a week for 3 weeks. During this time the dose is gradually increased by 0.5 ml. to 5 ml.

Dengue

(Break-bone Fever)

Definition. A disease characterised by fever and severe pains in the back and limbs.

Etiology. The causative agent is an ultra-microscopic and filterable virus which is present in the blood. It is conveyed from man to man by the mosquito *Aedes aegypti* (*Stegomyia fasciata*). The virus undergoes some development in the mosquito, the latter becoming infective in 11 days. The patient's blood is infective for the mosquito during the first 2 days of the illness. Large epidemics and sporadic cases occur. **Predisposing causes:** 1. **Locality:** The disease is met with in New South Wales, Florida, Brazil, the West Indies, Fiji, Syria, Greece, Turkey and Africa. 2. **Climate:** Heat and moisture are required. A previous attack usually confers immunity.

Pathology. The disease is rarely fatal, but cedema of the lungs has been noted.

Incubation Period. This is usually 4 to 10 days.

Clinical Findings. Three stages are described: *The invasion.* The onset is usually sudden with a rigor. The patient complains of aching in the head and eyes and excruciating pains in the lower part of the back and legs which cause complete prostration.

On Examination: The conjunctivæ are injected, the face is flushed, the skin generally hot and dry with some erythema. The temperature rises rapidly to 102° F. (38.9° C.) or higher. The blood shows a leucopenia of about 2,000 white cells per c.mm., owing to diminution of the polymorphonuclears which may fall to 40 or 50%. The urine often contains a trace of protein.

The remission. About the third day sweating occurs, with often nose-bleeding and diarrhoea, the temperature falls by lysis or crisis and the patient feels better. **Terminal fever.** About the fifth day the temperature rises again to 100° F. (37.8° C.) or so, and remains raised for about 24 hours. There is recurrence of the pains and an itching rash appears. This is usually morbilliform in character and starts on the palms and backs of the hands, spreading to arms, trunk and legs. It fades in 2 or 3 days, with slight desquamation.

Differential Diagnosis. The occurrence of the disease with its typical course in a warm climate is characteristic. It must be diagnosed from other conditions, such as influenza, acute rheumatism, malaria and measles.

Course and Complications. The course is usually as described.

Complications include : Epistaxis, bleeding from the gastro-intestinal tract or uterus, boils, peri-arthritis of the knees or ankles and post-dengue debility.

Prognosis. This is good. The disease is practically never fatal.

Treatment. *Prophylactic.* This is concerned with elimination of mosquitoes and prevention of their bites, as for yellow fever.

Curative. The patient should be kept in bed until the rash has gone. A saline aperient should be given at the onset. Drugs are required for the relief of pain, aspirin in doses of 10 gr. (0.6 G.) six-hourly, tab. codein co. 1 six-hourly, and in some cases a subcutaneous injection of morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (10 to 15 mg.).

Yaws

(*Frambæsia*)

Definition. A specific infective granuloma.

Etiology. Yaws is caused by the *Treponema pertenue*. This cannot be distinguished microscopically from the causative organism of syphilis. It is not a venereal disease and may be conveyed by direct contagion through a cutaneous abrasion and possibly by insect bites.

Predisposing causes: 1. Locality: East and West Africa, Malaysia, Philippine Islands, Fiji and Samoa, Burma, Ceylon, Brazil and West Indies. 2. Age: It is not congenital and occurs especially in children and young people. Over 60% of cases occur before the age of 15 years. 3. Race: Patients are usually natives.

Pathology. The "Yaw" is an infective granuloma. The disease is distinct from syphilis, but the Wassermann reaction is positive in the majority of cases.

Incubation Period. Probably a month or longer.

Clinical Findings. The onset is insidious with malaise, headache, pains in the muscles and bones, and there may be slight fever. The primary lesion may not be detected and may be single or multiple. It generally occurs below the knees or near the mouth and is called the "Mother Yaw." It is a papule varying in size up to 2 or 3 inches (5 or 7.5 cm.) in diameter, which becomes nodular, exudes fluid and forms a scab. The secondary stage: Some desquamation of skin occurs in about 8 months' time followed by the appearance of more papules which protrude, become red resembling a raspberry (*frambæsia*) and crust over. They may occur in any part of the body and after some weeks eventually drop off. They are painless but may itch, and treponemes are found in smears. Tertiary lesions form from ulceration of the Yaw.

Varieties. 1. "Crab" yaws affect the sole of the foot. 2. "Gangosa" is an ulcerating yaw in the palate. 3. "Goundou" is a nodular swelling on the nose. 4. "Juxta-articular nodules" may form tumours near the knees or elbows.

Differential Diagnosis. The disease can be distinguished from syphilis by the absence of a primary genital lesion and the absence of nervous manifestations, such as tabes and general paralysis.

Course and Complications. The average duration, if untreated, is about a year, but recurrences of secondary lesions may take place.

Prognosis. The disease is not usually fatal.

Treatment. Penicillin is the drug of choice. The dose is an intramuscular injection of 1·2 million units of a procaine preparation in 2% aluminium monostearate (PAM) for persons over the age of 10 years, and 600,000 units for children under the age of 10. Two injections a week for 2 weeks are usually sufficient for a cure.

Phlebotomus Fever

(*Sand-fly Fever. Papataci Fever. Three-day Fever*)

Definition. A specific disease characterised by headache and generalised pains, due to the bite of a sand-fly.

Etiology. Phlebotomus fever is caused by an ultra-microscopic filterable virus which is present in the patient's blood during the first 1 or 2 days of the illness. It is carried by a sand-fly (*Phlebotomus papatasi*). The virus probably undergoes changes in the fly's body, as the latter does not become infective for 6 days after biting a patient.

Predisposing causes: 1. **Locality:** The disease occurs in the eastern part of the Mediterranean, and in Mesopotamia, India and Persia.

2. **Climate:** Warmth and moisture are necessary.

Pathology. There are no post-mortem findings.

Incubation Period. This is 4 to 7 days.

Clinical Findings. The bite of the fly produces some local irritation and swelling. There may be malaise for a day or so before the onset, which is usually sudden with a rigor. The patient complains of frontal headache, pains behind the eyes, in the neck, back and limbs. There is often insomnia.

On Examination: The face is flushed and the conjunctivæ are red. The throat is congested and some vesicles may be seen on the mucous membrane. The tongue is furred in the centre. The temperature rises rapidly to 103° or 105° F. (39·4° or 40·5° C.) but the pulse remains slow, about 70 or 80. The blood: There is usually a leucopenia. The temperature falls in about 2 days and there may be some diarrhoea, epistaxis and sweating. The pulse becomes slower, 40 to 50. There is no rash.

Differential Diagnosis. Sand-fly fever must be distinguished from malaria, influenza and dengue. Examination of a blood film excludes malaria; the course of the disease and its occurrence where there are sand-flies usually serve to establish a diagnosis.

Course and Complications. The usual course is as described above. Rarely a recrudescence occurs with a rise of temperature to a lesser degree for a short time, about the fifth or sixth day.

Prognosis. This is good. The disease is never fatal.

Treatment. Prophylactic. Sand-flies should be destroyed and their breeding places eliminated by spraying with D.D.T. Dimethyl-phthalate should be applied to the wrists and ankles at night. Mosquito nets should be sprayed with D.D.T.

Curative. Liq. iodi mitis should be applied to the bites. The patient should be kept in bed for 5 or 6 days and the pains relieved by aspirin 10 gr. (0.6 G.) t.i.d.

Leishmaniasis

A group of diseases due to infection with protozoa of the Leishman-Donovan type. The group includes kala-azar and tropical sore.

Kala-azar

(Dumdum Fever. Black Fever)

Definition. A disease characterised by enlargement of the spleen, cachexia and irregular fever, due to infection with a specific protozoon.

Etiology. The protozoon causing kala-azar is the Leishman-Donovan body (*Leishmania donovani*). The protozoon appears in man as a small oval or cockle-shaped body, about $1.3 \times 8\mu$, with two nuclei. Although the parasite develops readily in the sand-fly, *Phlebotomus argentipes*, infection of man by the bite of this fly has not been proved. Infantile kala-azar is due to the *Leishmania infantum*, which is probably the same protozoon. **Predisposing causes:** 1. Locality: Kala-azar was first described in Assam, it occurs in other parts of India, in China, the Sudan, West Africa, etc. Infantile kala-azar is found around the Mediterranean. It is more prevalent in the country than in towns. 2. Climate: Warmth and moisture favour its appearance.

Pathology. The Leishman-Donovan body occurs in endothelial cells, especially in the spleen; in the blood it may be present in polymorphonuclear leucocytes. A flagellate stage is found in certain sand-flies and can be obtained on culture of the cockle-shaped bodies. Post-mortem, the spleen is enlarged and somewhat firm; the liver is also a little enlarged, and ulcers may be found in the small and large intestine. The marrow of the long bones is unduly red.

Clinical Findings. The incubation period is uncertain, varying from a few months to over a year. The disease usually begins insidiously, with progressive weakness, loss of weight, and malaise; there may be diarrhoea, sweating or bleeding from the nose or gums. In some cases the onset is more sudden, suggesting malaria, and in others resembling typhoid fever.

On Examination: In an established case the patient is wasted, and in Europeans the skin is seen to be pigmented. The spleen is enlarged and the liver may be palpable. The temperature is irregularly raised and may present 2 or 3 summits in the 24 hours. The pulse is proportionately frequent. The blood: There is anaemia and leucopenia is pronounced, about 2,000 per c.mm. Leishman-Donovan bodies are seen at times in polymorphonuclear leucocytes. There is an excess of gamma-globulin in the blood. Diagnosis may be confirmed by withdrawing some splenic tissue by spleen puncture, making a film and staining for Leishman-Donovan bodies. Sternal puncture will also show the Leishman-Donovan bodies in the monocytes, and this is a safer method of diagnosis than is splenic puncture.

Differential Diagnosis. Other causes of chronic enlargement of the spleen (see p. 544) should be excluded, if there is doubt as to the diagnosis. A blood examination usually excludes malaria, as does the response to antimalarial treatment. Finding the protozoon by sternal or spleen puncture settles the diagnosis.

Course and Complications. The average course of the disease, if untreated, is from a few months to 2 years, when death occurs from progressive weakness, or some septic complication, such as pneumonia or gangrene of the lungs.

Prognosis. The mortality has been lowered by antimony treatment from a previous 96% to about 2% except in the Sudan where very severe and drug-resistant cases are met with.

Treatment. Prophylactic. Healthy natives in a kala-azar district should be kept together at night and away from those infected with the disease. The sand-fly range is only a few hundred yards. D.D.T. sprays should be used and dimethyl-phthalate smeared on the skin and clothing. Nets to afford protection would have to be of too fine a mesh to be tolerated at night.

Curative. If there is severe anæmia a blood transfusion should be given. Sodium antimony gluconate, 0.3 to 0.6 G. in 6 to 10 ml. sterile distilled water, should be injected intravenously daily for 3 to 10 days. For cases which are resistant to antimony, especially those occurring in the Sudan, the aromatic diamidines are available, such as stilbamidine and pentamidine isethionate. The latter is given daily intramuscularly or intravenously for 12 to 15 days, the usual dose being 2 mg./kg. body weight. Headache, giddiness, flushing, abdominal pain or low blood pressure may be relieved by the oral administration of Anthisan 100 mg. half an hour before the injection.

Tropical Sore

(*Dermal Leishmaniasis. Delhi Boil. Oriental Sore. Baghdad Boil. Aleppo Sore*)

The causative organism is the *Leishmania tropica*, which cannot be distinguished from the *L. donovani*. Ulceration occurs in the skin and on mucous membranes; the disease is probably spread by a sand-fly, the *Phlebotomus papatasi*. In the American tropics this form of leishmaniasis is called Espundia.

Local treatment consists in the application of solid carbon dioxide, pure phenol, superficial X-rays or radium. In addition, 2 ml. of a 5% solution of emetine hydrochloride may be injected into the periphery of the lesion. Other substances used for local infiltration include 2 ml. of berberine sulphate (2%), or Neostam (2%), at weekly intervals.

CHAPTER XV

THE PARASITIC WORMS

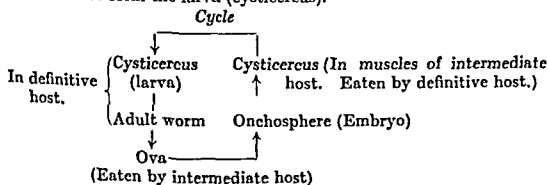
THE CESTODES

(Tape Worms)

Definition. Segmented flat worms, usually hermaphrodites.

Anatomy. The tape worms consist of a head and neck (scolex) and segments (proglottides). The segments near the head are immature, the intermediate ones contain sexual glands and the terminal ones ova. They have no alimentary canal.

Varieties. The most important varieties are the *Tænia solium*, the *Tænia saginata*, the *Diphyllobothrium latum* (*Dibothriocephalus latus*), the *Echinococcus granulosus* (*Tænia echinococcus*) and the *Hymenolepis nana* (*Tænia nana*). Man is infected by eating the larvæ in meat or fish which is raw or insufficiently cooked. The larva is known as a cysticercus if it forms one cyst and one scolex (as in *T. solium* and *T. saginata*), and as an echinococcus if it forms many cysts and many scolices in each cyst (as in *E. granulosus*). The larva of the *D. latum* is a plerocercoid and elongated like a worm. The larva develops in the definitive host into the adult worm, and the eggs which pass out in the fæces are eaten by the intermediate host. The outer layer is dissolved in the alimentary canal and the contained embryo (onchosphere) is liberated. This passes into the tissues to form the larva (cysticercus).



The ovum of the *D. latum* forms a ciliated embryo; this is eaten by certain crustacea (such as *cyclops strenuus*) and forms a proceroid larva. The cyclops containing the proceroid is eaten by a fish and becomes encysted as a plerocercoid larva. Man eats the fish, and is infected, the larva developing into the adult worm. In *E. granulosus* infection man eats the ova and the larva formed develops in his tissues, the adult form occurring in animals such as the dog.

The *Tænia Solium*

(The Solitary Tape Worm. The Armed Tape Worm. The Pork Tape Worm)

The chief features are as follows :

Infection. By eating imperfectly cooked "measly" pork containing the larvæ (*Cysticerci cellulosa*).

Locality. World-wide distribution.

Hosts. Definitive: Man. Intermediate: The pig or rarely man (*Somatic taeniasis*).

Length of Adult Worm. About 10 feet (3 metres).

Head. 1 mm. in diameter. Globular, with 4 suckers and a rostellum armed with 2 rows of 14 hooklets. Neck, thin.

Segments. About 1,000. Contain a uterus with about 10 lateral branches; the genital pore is lateral and alternates regularly. Mature segments are three times as long as they are broad (see Fig. 69).

The Ova. Circular. Diameter about 35 μ .

The Onchosphere (embryo). About 20 μ in diameter. Has 6 hooks.

The Cysticercus Cellulosæ. Like

a little bladder; oval, about 5 to 20 mm. long. Single scolex forms in it.

Segments containing ova are passed in man's faeces and are eaten by the pig. Rarely *somatic taeniasis* occurs in man, either by transference of ova by his fingers to the mouth, or owing to segments containing ova being regurgitated into his stomach. The cysticerci (bladder worms) may then develop under the skin as small nodules, or in the brain, causing epilepsy, in the eyes, or muscles. They may be revealed by X-ray examination, and must not be confused with the cysts of the *Trichinella spiralis*. The latter are probably too small to be seen radiologically.

The *Tænia Saginata*

(*Tænia Mediocanellata*. The Unarmed Tape Worm. The Beef Tape Worm. The Fat Tape Worm)

Infection. By eating imperfectly cooked beef infected with the *Cysticercus bovis*.

Locality. World-wide distribution.

Hosts. Definitive: Man. Intermediate: Cattle.

Length of Adult Worm. About 20 feet (6 metres).

Head. 2 mm. in diameter, Pear shaped, with 4 suckers, but no rostellum and no hooklets. Neck, medium size.

Segments. About 2,000. Contain a uterus with about 20 lateral

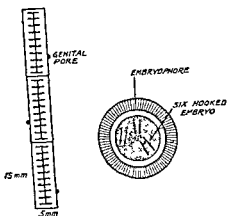


FIG. 69. *T. SOLIUM*. MATURE SEGMENTS. (Natural size.)

T. solium: faecal ovum (onchosphere), brown, circular, 35 μ in diameter. ($\times 500$.)

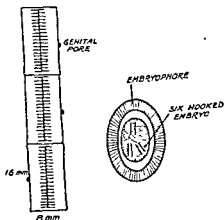


FIG. 70. *T. SAGINATA*. MATURE SEGMENTS. (Natural size.)

T. saginata: faecal ovum (onchosphere), brown, oval, 38 $\mu \times 25 \mu$. ($\times 500$.)

branches; the genital pore is lateral and alternates irregularly; the mature segments are twice as long as they are broad (see Fig. 70).

The Ova. Oval, measuring $88\ \mu$ by $25\ \mu$ approximately.

The Onchosphere (embryo). Head has 6 hooks.

The Cysticercus Bovis. 8 mm. by 5 mm. Single scolex forms in it.

The segments containing ova are passed in man's faeces and are eaten by the ox.

The Diphyllobothrium Latum

(*The Dibothriocephalus Latus. The Russian Tape Worm*)

Infection. By eating caviare or imperfectly cooked fish.

Locality. Russia, the Baltic, Switzerland.

Hosts. Definitive: Man. Intermediate: Fish such as pike, perch, salmon, trout, and grayling.

Length of Adult Worm. About 80 feet (9 metres),

Head. 8 mm. long. Olive shaped, with a suction groove on its dorsal and ventral sides. There are neither rostellum nor hooklets.

Segments. About 8,000. Contain a central rosette uterus and a ventral genital pore. They are broader than they are long (see Fig. 71).

The Ova. Oval, measuring about $60\ \mu$ by $40\ \mu$, with an operculum.

The Onchosphere. Ciliated and free swimming. It is eaten by crustacea (such as the *Cyclops strenuus*).

The Proceroid Larva. Elongated, oval, $5\ \mu$ long.

The Plerocercoid Larva. Worm-like, about 6 mm. long. Man passes free ova in his faeces.

Clinical Findings. Infestation of man with *T. Solium*, *T. saginata* or with *D. latum* may give rise to vague symptoms of indigestion or to marked hunger with bodily wasting. A severe megaloblastic anaemia with a low serum B_{12} level may occur with *D. latum* infestation. It is estimated that in Finland 250,000 people are infested, but only 0.5% suffer from anaemia.

Treatment. Prophylactic. Meat and fish must be adequately inspected for cysticerci, and properly cooked. Beef should be thoroughly cooked and not eaten underdone.

Curative. The patient may be given dichlorphen (Anthiphen). 0.5 G. tab., 12 tabs. with tea before breakfast. For small children 8 tabs. should be given in jam. The bowels will be opened in about 2 hours, and the disintegrated worm passed. Alternatively, niclosamide (Yomesan), 0.5 G. tab., may be given, 2 tabs. chewed and swallowed, repeated after 1 hr. The same dose is given to children. For *T. solium* infestation some prefer to give, after preliminary starvation and purgation, ext. filicis liq. 15 m. (1 ml.) in an emulsion at 9 a.m., 9.15 a.m., 9.30 a.m., 9.45 a.m., and 30 m. (2 ml.) at 10 a.m., followed by mag. sulph. 240 gr. (16 G.) at noon. Some authorities state there is a danger of

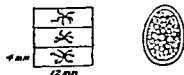


FIG. 71. THE DIPHYLLOBOOTHRIUM LATUM. MATURE SEGMENTS. (Natural size.)

Diphyllobothrium latum: faecal ovum, brown, oval, $60\ \mu$ \times $40\ \mu$. (\times 250.)

producing cysticercosis (somatic taeniasis) if dichlorophen or niclosamide is given for *T. solium* infestations, owing to the liberation of large numbers of eggs in the motions, some of which may be ingested. If the head does not come away, fresh segments will appear in the motions in about 3 months. A second treatment should then be given.

The Echinococcus Granulosus

(The *Tænia Echinococcus*)

Infection. Man is infected by ova excreted by dogs, if the dog licks the man's hands or his dishes. Infection may also occur from drinking water or from eating uncooked vegetables contaminated by the ova. The dog is infected by eating meat containing the hydatid cysts.

Locality. Australia and Iceland.

Hosts. Definitive: The dog, wolf or jackal. Intermediate: Man, sheep, oxen and pigs.

Length of Adult Worm. About $\frac{1}{2}$ inch (6.2 mm.).

Head. Resembles that of *T. solium* in miniature, being 0.3 mm. in diameter. There are 4 suckers and a rostellum with 2 rows of about 20 hooklets in each.

Segments. Four. The terminal segment is mature and contains ova.

The Ova. Oval, measuring about 85μ by 25μ . The ovum, when swallowed by man, liberates its six-hooked embryo (onchosphere); this migrates to the tissues, especially the liver, and forms a hydatid cyst.

The Hydatid Cyst. There is an inner granular or germinal layer, from which the daughter and grand-daughter cysts form. These contain many scolices; the middle layer is laminated; the outer layer is fibrous and formed from the tissues of the host. The contents are clear fluid, specific gravity about 1.006. The fluid contains 1% of sodium chloride, a trace of sugar, some hooklets and no protein. The cyst occurs especially in the liver, but may be found in the lungs, brain, kidneys or heart.

Hydatid Disease

Clinical Findings. The patient does not usually notice any ill health unless the hydatid cyst causes mechanical pressure symptoms or some complication occurs.

Hydatid of the Liver. If the cyst is deep-seated no tumour is felt, but there may be a palpable swelling which sometimes fluctuates. More rarely the hydatid thrill is felt by placing one hand over the swelling and tapping it sharply with the fingers of the other hand.

Hydatid of the Lungs. This is described on p. 196.

Hydatid of the Kidneys. This may cause a renal tumour.

Hydatid of the Brain. This causes symptoms of a cerebral tumour.

Hydatid of the Heart. This may cause sudden death.

The blood may show an eosinophilia and the Casoni intradermic test is positive (see p. 83).

Course and Complications. The cyst may grow to 5 or 6 inches (12·5 or 15 cm.) in diameter; it may atrophy, calcify or its contents may suppurate. Rupture may occur into the peritoneum, the stomach, intestines, the pleura, the inferior vena cava or the bile ducts. Rupture may be accompanied by shock and by urticaria, and in cases of intraperitoneal rupture secondary cysts may form.

Prognosis. The disease is serious. Frequently, however, the cyst dies and inspissates. Suppuration or rupture make the outlook more grave.

Treatment. There is no medical treatment. If possible, the cyst should be removed surgically without rupture.

The Hymenolepis Nana

(*The Tænia Nana. The Dwarf Tape Worm*)

This worm infests especially children in America, Egypt and Southern Europe. It is 25 to 40 mm. long and 1 mm. broad. It has a rostellum with 4 suckers and a single row of about 80 hooklets. There are about 200 segments. There is probably no intermediate host, the eggs which are liberated in the intestine developing into adult worms.

Treatment. *Ol. chenopodii* may be given. The dose for children is one drop for each year of age on a lump of sugar, followed 2 hours later by a dose of castor oil appropriate to the age of the child. Alternatively the treatment described in p. 771 may be given.

THE TREMATODES

(*Flukes*)

The trematodes are flat non-segmented leaf-like worms, usually hermaphrodites, possessing a mouth and 1 or more suckers. The most important varieties which are parasitic in man are the schistosoma and the paragonimus (lung fluke); the fasciola or liver fluke rarely infests man.

Schistosomiasis

(*Bilharziasis*)

There are three varieties.

Urinary Schistosomiasis

(*Endemic Hæmaturia*)

Etiology. Endemic hæmaturia is caused by the *Schistosoma hæmatobium* (*Bilharzia hæmatobium*). Man is infected by cercariæ (young swimming forms of the trematode) which pierce his skin when bathing or paddling, and infection may occur by drinking water. The cercariæ pass to the portal vein, and in about 6 weeks develop into the adult male and female forms of the *S. hæmatobium*. The male is flat, about 15 mm. by 1 mm., and the female is slender and round, about 25 mm. by 0·25 mm. They migrate against the blood stream from the portal to the pelvic veins and veins of the bladder or rectum, the male curves from side to side to form a gynæcophoric canal in which he embraces the female; when they have reached the small veins, the female leaves the male and migrates to the smallest vein allowing her

passage. The ova are then extruded. The ovum is about $190\ \mu$ by $70\ \mu$, and has a sharp terminal spine; this penetrates the blood vessel, and the ovum is pushed through the vessel by the blood stream. It then ulcerates its way into the submucous tissues and through the mucous membrane of the bladder or rectum. The ova are chiefly passed in the urine. On coming in contact with water, an embryo or ciliated miracidium hatches out. This enters a spiral fresh-water snail, such as the *Bullinus contortus*. Sporocysts form, and cercariæ are liberated into the water from the snail, completing the cycle. The disease is met with in Africa, Arabia and Iraq.

Pathology. Post-mortem, the mucous membrane of the bladder is red, thickened in patches and polypi may be seen. The muscular wall is hypertrophied. The prostate may be enlarged and the ureters dilated. Ova may be seen in the submucous tissues of the bladder or in the prostate; the liver may be cirrhotic.

Incubation Period. 1 to 8 months.

Clinical Findings. The first symptoms appear a few weeks after infection. They constitute the toxæmic stage. The patient complains of urticaria, malaise, with perhaps abdominal pain.

On Examination: The temperature is raised and the blood shows an eosinophilia which may reach 50%. A positive complement fixation may be obtained by using as an antigen an extract of the liver of infected snails.

Local symptoms may not be noticed for a few months, or even years. The patient then complains of passing blood, usually at the end of micturition, with perhaps frequency, scalding, and pain in the perineum or suprapubic region. He may also pass blood and mucus in his motions.

On Examination: The patient is often pale or sallow. The urine: The deposit shows ova, red corpuscles and pus cells. The blood may show a leucocytosis of about 15,000 per c.mm., with an eosinophilia of about 12%. The complement fixation test is usually still positive. Cystoscopy may reveal an inflamed vesical mucous membrane, and white patches may be seen due to submucous ova.

Differential Diagnosis. Other causes of hæmaturia, such as a calculus, cystitis, etc., must be excluded. The presence of ova in the urine is diagnostic, but a calculus may also be present.

Course and Complications. The disease, if untreated, pursues a chronic course for many years, and, if the patient is not destroyed by complications, spontaneous cure usually results. Complications include: Cystitis, vesical calculus, hydronephrosis, pyonephrosis, carcinoma of the bladder, urethral fistula or stricture, etc.

Prognosis. This depends upon the severity of infection, the presence of complications and the institution of adequate treatment.

Treatment. *Prophylactic.* Bathing or paddling in endemic areas should be forbidden, and drinking water should be boiled. The snails may be destroyed by cutting off the water of the irrigation canals periodically for 2 weeks during the dry season. Carriers should have their infestation cured by treatment.

Curative. Sodium antimony tartrate is injected slowly into a vein. The injection should be given about 2 hours after a meal. A 0.5% solution is used, on the first day 8 ml., on the third day 12 ml., on the fifth day 16 ml., on the seventh day 20 ml., and on the ninth day and on subsequent alternate days 24 ml., until a total of 320 ml. has been injected. The hæmaturia may be temporarily increased. The urinary deposit should be examined daily for ova, which, as they are killed, shrivel, darken, and when placed in water will not hatch out. A cough is often noticed during the injection. This is due to the antimony reaching the lungs. If toxic symptoms follow an injection, the next dose should not be increased. Toxic symptoms include tightness of the throat or chest, abdominal pain, and a metallic taste. If there is collapse at the injection, Pituitrin 1 ml. or inject. adrenaline (B.P.) 1 in 1,000, 0.5 ml. should be injected intramuscularly. If the patient has heart or kidney disease, the antimony is contraindicated. Sodium antimony dimercaptosuccinate (stibocaptate) is less toxic. It is given by intramuscular injection, 0.25 G. daily for 4 doses. When the veins are difficult, stibophen (Fouadin), also a trivalent antimony preparation, may be injected intramuscularly, using a 6.3% solution. Ten to fifteen injections are given on alternate days. For an adult the dose is 1.5 ml., followed by 3 ml., the subsequent doses being 5 ml. Good results have also been obtained in urinary schistosomiasis with Nilodin (miracil D). It is put up in tablets of 200 mg. and administered by mouth. The dose is 22 mg./kg. body weight for 16 days. It is stated that in cases of *S. hæmatobium* and *S. mansoni*, but not in *S. japonicum* infections, nitrothiamidazone (Ambilhar), will effect a cure in practically all cases if taken in the correct dose and for the correct number of days. The drug is put up in 500 mg. scored yellow tablets. The dose is 25 to 30 mg./kg. body weight for 5 to 7 days. Side effects include painful abdominal spasms.

Intestinal Schistosomiasis

Etiology. This disease is caused by the *Schistosoma mansoni* (*Bilharzia mansoni*). The adult trematodes are found in the mesenteric veins, and their ova pass through into the rectum. The ova have a lateral sharp spine. The intermediate host is a flat fresh-water snail, the *Planorbis boissyi*. The life history resembles that of the *S. hæmatobium*. Intestinal schistosomiasis occurs in Egypt, the Congo, Nigeria, the West Indies and the northern part of South America.

Pathology. Post-mortem, the mucous membrane of the rectum and colon is thickened, and there are papillomatous swellings. The liver may be fibrotic ("pipe stem" cirrhosis) and ova are found in it.

Clinical Findings. An early toxæmic stage with fever and urticaria occurs, followed in about 2 months' by dysenteric symptoms, with blood and mucus in the motions. The ova are found in the fæces, and the blood shows an eosinophilia and gives a positive complement fixation test. In Egypt a special type occurs associated with enlargement of the liver and spleen. Nodular lesions may form in the lungs,

which may lead to pulmonary endarteritis and right heart failure. The brain may also be involved with hemiplegia or epileptiform convulsions. Anæmia and ascites are present. This variety is called Egyptian splenomegaly.

Treatment. This is by sod. antimon. tartrate, stibophen or Ambilhar as for urinary schistosomiasis (see above).

Eastern Schistosomiasis

Etiology. Eastern schistosomiasis is caused by the *Schistosoma japonicum* (*Bilharzia japonica*). The trematodes are found in the mesenteric veins, and the ova pass into the large intestine. The ova have no spines, but a small lateral knob may be seen. The intermediate host is the *Hemibia japonica*, a fresh-water mollusc. The life history resembles that of the types described above. The disease is met with in China, South Japan, the Philippine Islands and Upper Burma.

Pathology. Post-mortem, the liver is enlarged, cirrhotic and contains ova; the spleen is enlarged, but usually free from ova; ova may be found in the brain. The mucous membrane of the large intestine is thickened and polypi may be seen.

Clinical Findings. An early toxæmic stage occurs with fever, urticaria and eosinophilia. Later, there are abdominal symptoms, with pain and dysentery.

On Examination: The liver and spleen are enlarged and there may be ascites. The ova are found in the fæces.

Treatment. This consists in giving injections of sodium antimony tartrate or stibophen, as described above.

Paragonimiasis

Etiology. Paragonimiasis is caused by the *Paragonimus westermani* (*Distoma ringeri*). The fluke is about $\frac{1}{8}$ inch (8 mm.) long.

Pathology. The parasites occur in the lungs.

Clinical Findings. The flukes are the cause of endemic hæmoptysis.

Treatment. Bithionol (Actamer) 2 to 2.5 G. is given on alternate days for 10 days.

Fascioliasis

Etiology. Fascioliasis is caused by the *Fasciola hepatica* (*Distoma hepaticum*).

Pathology. The flukes are found chiefly in the livers of sheep. Man is infected by eating raw water-cress. A small epidemic occurred in Hampshire in the autumn of 1958. After an invasive phase characterised by malaise, allergic and toxic symptoms and eosinophilia, there is severe pain in the liver region and a sudden rise of temperature. The liver is enlarged. Diagnosis is established by finding ova in the fæces.

Treatment. It is difficult to rid the fæces of ova. Symptomatic improvement is obtained with chloroquine, but early treatment with emetine may be more successful in curing the disease.

THE NEMATODES

These are cylindrical non-segmented, unisexual worms. The following are the most important varieties occurring in man: *Ascaris lumbricoides*, *Enterobius (oxyuris) vermicularis*, *Trichuris trichiura* (*trichocephalus dispar*), *Trichinella spiralis*, *Strongyloides stercoralis*, *Ankylostoma duodenale*, *Necator americanus*, *Wucheria (filaria) bancrofti*, *Loa loa*, *Dracunculus medinensis* and the *Onchocerca volvulus*.

Ascariasis

(Round Worm Disease)

Etiology. Ascariasis is caused by the *Ascaris lumbricoides*.

The Adult Worm. Male, average size 20 cm. (8 inches) in length and 0.8 cm. ($\frac{1}{4}$ inch) in diameter. Female, average size 30 cm. (12 inches) in length and 0.5 cm. ($\frac{1}{2}$ inch) in diameter. They are light brown in colour with pointed ends, and live in the small intestine in man and in animals such as the pig. Their eggs, which measure about 70μ by 60μ , are passed in the faeces. Man is infected by swallowing the eggs in water or contaminated uncooked food-stuffs. When ingested, the larvæ, which have developed inside the eggs, pass out and are believed to make their way to the liver and lungs, then to the trachea, larynx, œsophagus, stomach and intestine, where they develop into adult worms. Infestation is more common in children than in adults.

Pathology. Post-mortem, the worms are found chiefly in the upper part of the small intestine, and they may cause obstruction of the bile or pancreatic ducts, of the appendix or of the intestine. They may also perforate the intestine and cause peritonitis.

Clinical Findings. The patient may be unaware of their presence, or complain of vague symptoms of indigestion, flatulence, cutaneous irritation or urticaria. Fretfulness and convulsions occur in children. In some cases asthma or dysenteric symptoms are present. The worms may enter the stomach and be vomited, or pass up the œsophagus during the night, coming out through the mouth or nose. When the larvæ are traversing the lungs they may give rise to a febrile disturbance with cough and expectoration. On examination of the faeces the characteristic ova are found or a worm is seen.

Course and Complications. The patient often remains infected for several years, but the worms tend to die unless auto-infection from the ova in the patient's own faeces occurs. Such complications as appendicitis, intestinal obstruction or perforation, jaundice, pancreatitis or laryngeal obstruction may rarely occur.

Treatment. *Prophylactic.* Uncooked vegetables should be well washed before consumption.

Curative. A single dose of bethovenium hydroxynaphthoate (Alcopar) 5 G. (= 2.5 G. base) may be given, with a half dose for children. The stools should be subsequently examined for ova. If they are present, the treatment must be repeated to expel the remaining worms. Satisfactory results are also obtained with Antepar Elixir. This contains, as

its active principle, piperazine citrate, equivalent to 500 mg. piperazine hydrate in 60 m. (4 ml.), in stable combination. The dose is 50 to 75 mg./kg. body weight for 7 days.

Enterobiasis

(*Oxyuriasis. Threadworm Disease. Pinworm Disease*)

Etiology. The disease is caused by the *Enterobius (oxyuris) vermicularis*.

The Adult Worm. The male, average length 8 mm. The female, average length 10 mm. The worms are white and threadlike, and live in the cæcum and colon. The female passes outside the anus and lays her eggs. The patient scratches and the ova are transferred on the fingers to the mouth, the ova hatching out in the intestine. The eggs measure about $50\ \mu$ by $25\ \mu$ and are flat on one side. Man is infected by ingesting the ova in water or by contaminated uncooked food-stuffs. Air-borne infection may also occur, as ova are present on objects at all levels in all rooms in infested households, familial infestation being very common. Auto-re-infection is very liable to occur. Fertilisation takes place in the small intestine, after which the male worm dies and the female passes to the cæcum, as described above. The disease occurs in adults and in children.

Clinical Findings. Threadworms are an important cause of restlessness and irritability in children. In adults they should be remembered as a cause of pruritus ani. They may also be the cause of appendicitis. Children complain of itching of the anus, and there may be frequency of micturition, vaginitis or prolapse of the rectum. Ova are not often found in stool examination, and the best method of detecting infestation is by using a swab consisting of a glass rod tipped with a small square of cellophane. This is stroked over the perianal region, and the cellophane is placed between a glass slide and a cover slip and examined for ova.

Treatment. Prophylactic. Uncooked vegetables should be well washed before consumption.

Curative. All infested members of a household must be treated. The faeces should be examined for ascaris ova and if present the ascaris infestation should first be treated. The hands should be scrubbed after the bowels are opened, before meals, before the morning cup of tea, and after taking off any article of clothing in contact with the skin. The nails must be kept short and a child should wear gloves and tight-fitting knickers at night to prevent scratching. Antepar Elixir may be given, as described above, or a single dose of Pripsen granules. This is a mixture of piperazine phosphate and Senokot. The dose for children of 2 to 5 years is 3 teaspoonfuls (3 G. piperazine phosphate). For children aged 6 to 12 years the dose is 4 teaspoonfuls (4 G. piperazine phosphate). A single dose of perivinium embonate (Vanquin), it is said, will clear the majority of cases of threadworm infestation. The suspension contains 10 mg./ml. and the dose is 5 ml. of the suspension/22 lb. (10 kg.) body weight. Vanquin colours the stools red.

Trichuriasis

(Whipworm Disease)

Etiology. Trichuriasis is caused by the *Trichuris trichiura* (*trichocephalus dispar*).

The Adult Worm. The male, average length 40 mm. (1½ inches). The female, average length 50 mm. (2 inches). The worms are grey in colour; the anterior extremity ends in a fine thread. The worms are found in the cæcum and colon. The eggs are brown, barrel-shaped with an albuminous plug at each end, and measure about 50 μ by 22 μ . Man is infected by water and contaminated uncooked food. The larva is liberated from the ovum in the stomach and probably passes through the liver, lungs, trachea and œsophagus to the intestines. The worms are said to pierce the mucous membrane with their fine extremity which prevents their being dispelled by anthelmintics.

Clinical Findings. The worms usually produce no symptoms, but may cause appendicitis or chronic diarrhœa, with a microcytic hypochromic anæmia and eosinophilia. The ova are found in the fæces.

Treatment. Dithiazamine iodide (Telmid) is given in doses of 200 mg. t.i.d. for one day, then 200 mg. for 4 to 21 days for an adult, and for children 20 mg./kg. body weight in 3 divided doses for a week. It is put up in 100 mg. tab.

Trichiniasis

(Trichinosis. Trichinelliasis)

Etiology. Trichiniasis is caused by the *Trichinella spiralis*.

The Adult Worm. The male, average length 1.6 mm., diameter 0.04 mm. The female, average length 4 mm., diameter 0.06 mm. Man is usually infected by eating raw or partially cooked ham, pork, or pork sausages, containing encysted trichinellæ. Pigs are infected either by eating raw garbage containing pieces of infected pork or by eating infected rats. The former method is very prevalent in America. Larvæ develop from the cysts and form adult worms which live in the small intestine. The larvæ produce embryos which pass by lymphatics or blood vessels to striated muscles and encyst coiled up near the tendinous insertions of the muscles. They are found especially in the intercostal muscles, diaphragm, the muscles of the neck, upper arm and calf. Calcification may occur in the cyst wall. The disease is common in America and in Germany.

Incubation Period. This varies from 5 to 10 days.

Clinical Findings. Three stages were originally described: *The Invasion Stage.* This is characterised by malaise, vomiting and watery diarrhœa, with fever and at times delirium. *The Migration Stage.* During the second week of the illness pains occur in the arms and legs. There may be difficulty in breathing or in mastication. An urticarial rash may also appear, with œdema of the legs and face. The blood

shows a leucocytosis of about 20,000 per c.mm., with an eosinophilia of about 40%. Adult worms are rarely found in the faeces. *The Encystment Stage.* This usually gives rise to no symptoms.

Epidemics occurred in England in 1941 in which the preliminary gastro-intestinal symptoms were very slight and in some cases constipation was a prominent feature. The onset was characterised by fever of 101° to 102° F. (38.3° to 38.9° C.), swelling of the eyelids, face and occasionally limbs, and frontal headache. "Splinter hæmorrhages" were seen under the nails. In some cases meningeal or encephalitic symptoms were present and in about half the cases a dry cough was an initial symptom. Muscular pains were noted about 8 days after the onset, and temporary mental changes, such as melancholia, were not infrequent. The urine was usually free from protein and the blood showed an eosinophilia of about 40%. Asymptomatic infestation also occurs, in which no symptoms of the disease are manifested during life, but post-mortem encysted worms are found in the diaphragm.

Differential Diagnosis. Trichiniasis may be mistaken for acute nephritis, dermatomyositis, or sinusitis owing to the orbital oedema. The muscular pains may suggest acute rheumatism. The nervous symptoms may lead to a diagnosis of meningitis or of encephalitis. The fever and gastro-intestinal symptoms may resemble those of food poisoning or enterica group infections. The initial fever and cough may cause confusion with influenza or bronchitis. The correct diagnosis is suggested by the fever, leucocytosis and eosinophilia. It is established by finding the larvæ in the blood during the first 2 or 3 weeks of the illness. For this purpose 5 ml. of blood are laked with 10 ml. of water, and the centrifugised deposit is examined microscopically. The adult worms are seldom found in the faeces. Muscle biopsy will demonstrate the presence of *T. spiralis* in the majority of cases after the fourth week of the illness; a small portion of the pectoralis major, deltoid or gastrocnemius muscle is examined. Intradermic injection of a saline suspension of powdered larvæ gives a positive reaction, as shown by the formation within 5 minutes of a wheal and an erythematous zone, in nearly all people for 6 months after infestation. Reports that calcified cysts can be demonstrated radiologically in the muscles in long-standing cases are probably incorrect. The cysts are usually too small to be thus revealed, and confusion has arisen by mistaking encysted cysticerci for them.

Course and Complications. The feverish stage may last for 2 to 8 weeks, and the muscular pains and weakness for several months. Death may occur from myocarditis or encephalitis.

Prognosis. In an outbreak in Berlin in 1930, 10 out of 70 cases proved fatal. The mortality was 16% in a series of 1,550 cases in America, and no deaths occurred in 500 cases in the Wolverhampton neighbourhood in the English epidemic of 1941.

Treatment. Prophylactic. Infected meat must be avoided, and ham, pork, and pork sausages should be well cooked.

Curative. During the invasion period the patient should be given calomel 3 gr. (0.2 G.), followed by mag. sulph. 120 gr. (8 G.) in the

morning or castor oil $\frac{1}{2}$ fl. oz. (15 ml.), to drive out the worms before the embryos are formed. This treatment should be repeated again the next day. Corticosteroids should be given for myocarditis. There are no measures available for eliminating the cysts from the muscles.

Strongylosis

The *Strongyloides stercoralis* enters the body through the skin and lives in the submucous tissues of the small intestine in man. The female worm measures 2.5 mm. by 0.3 mm. The male is not found in the intestine. It is thought that the worms cause diarrhoea at times (Cochin-China diarrhoea).

Treatment. Dithiazamine iodide (Telmid) should be given, as for Trichuriasis.

Ankylostomiasis

(*Uncinariasis*. Hookworm Disease. *Miner's Anaemia*)

Etiology. Ankylostomiasis is caused by a small nematode, of which there are two types, the *Ankylostoma duodenale* and the *Necator americanus*.

The *A. duodenale*. The male is about 9 mm. by 0.5 mm. in size and the female slightly larger. Its name implies that it has a bent mouth which contains 4 teeth. It lives chiefly in the jejunum, attached by its mouth to the mucous membrane from which it sucks blood. Many eosinophil cells congregate at the site of its attachment.

The *N. americanus*. This is slightly smaller. Thousands of eggs are formed which are excreted from the human intestine. When these come in contact with damp soil or water, embryos hatch out and enter the skin of man, usually through the feet, producing "ground itch." They then pass in the circulation to the heart and lungs. They burrow into the bronchi and are carried with the mucus up the trachea and pass down the oesophagus into the small intestine. Locality: The disease occurs throughout the sub-tropical world, that due to the *Ankylostoma duodenale* being met with in the Mediterranean and Southern European areas, also in certain districts in India and Northern China. It has also been found amongst tin miners in Cornwall and coal miners in Belgium. It is a disease of the country rather than of towns, and affects children and adults. The *N. americanus* is found in North and South America and also in Central Africa, India, the Philippines, Ceylon, etc.

Pathology. Post-mortem, the body is well-nourished, but pale. The heart, liver and kidneys are fatty, and localised hæmorrhages are seen in the mucous membrane of the small intestine. Serous effusions may be present. Over a thousand worms may be found in the intestine.

Clinical Findings. The local lesions in the feet ("ground itch") result in the formation of vesicles and pustules, which heal in a week

or so. It is several months before the general symptoms are felt. The patient complains of progressive weakness, shortness of breath, and palpitations. There may also be abdominal pain, flatulence, and constipation or diarrhoea. The appetite is good, but pica (dirt eating) is a feature of the disease.

On Examination : The complexion is pale or sallow. The temperature may be slightly raised. There may be œdema of the feet with dilatation of the heart. The spleen is not enlarged. The blood : The anæmia is of a microcytic hypochromic type. The characteristic feature is an eosinophilia of about 20%. The stools usually show blood either by naked eye or by occult blood tests. Ova are seen microscopically. Apparently healthy immigrants from the tropics to Britain may carry the parasites.

Differential Diagnosis. Other causes of anæmia are excluded by the eosinophilia and the presence of the ova in the fæces.

Course and Complications. The disease pursues a prolonged course if untreated, and results in much economic loss amongst workers in the tropics. Growth is much diminished in infected children. Dysentery with blood and mucus in the motions, polyarthritis or nephritis may occur.

Prognosis. This is usually good, but at times the disease is rapidly fatal.

Treatment. Prophylactic. Latrines should be provided and their use enforced in endemic zones and the feet protected by boots. Drinking water should be boiled.

Curative. Bephenium hydroxynaphthoate (Alcopar) should be given, as for Ascariasis.

Filariasis

Etiology. There are several types of these small nematodes which produce disease in man, the most important being the *Wucheria (filaria) bancrofti*, the *Loa loa* and the *Onchocerca volvulus*.

Wucheria bancrofti

(*Filaria bancrofti*)

Infection is conveyed to man by mosquito bites, chiefly by the *Culex fatigans*. The female mosquito introduces the embryos into human beings, and they pass to the lymph vessels and nodes, where they develop into the adult filaria. The male is about 40 mm. (1½ inches) long and the female twice its length. They are very fine and resemble a coiled hair. The female produces large numbers of embryos (microfilariae), which pass into the blood stream. They measure about 0.3 mm. long by 7.5 μ wide. These are taken by a biting mosquito, and, after undergoing changes in its body, are injected again into

man. The embryos are practically absent from the peripheral circulation of man during the day, being located then chiefly in the lungs and kidneys. They pass into the peripheral circulation during the night, beginning to migrate before the patient goes to sleep, reaching their maximum about midnight and diminishing in numbers before he awakes. This corresponds with the night activity of the mosquito. If the patient sleeps by day, the periodicity is altered. In the Pacific Islands the *W. bancrofti* shows no periodicity, the intermediary mosquito, the *Aedes variegatus*, there biting during the day. The disease occurs in the tropical portions of North and South America, the West Indies, in North Africa, Central Africa, China, Japan, North Australia, India and Malaysia.

Pathology. The changes produced by the adult filariæ result from lymphatic obstruction and secondary inflammation of lymphatics. In tropical elephantiasis adult filariæ can often be found in the neighbouring lymph nodes. The lymph nodes and vessels become fibrosed and the embryos cannot pass through them into the circulation. The embryos are not known to produce any pathogenic effects.

Incubation Period. This is probably a matter of 4 or 5 years.

Clinical Findings. The results produced by the adult worms are variable, and include:—**Lymphangitis:** Painful red lines form under the skin and the neighbouring lymph nodes are enlarged. There is constitutional disturbance and fever, and probably a secondary streptococcal infection of the lymphatics. **Elephantoid fever:** Periodical attacks of fever with an initial rigor and terminal sweating occur, somewhat resembling malaria. The deep lymph nodes are probably inflamed. Other local results of lymphangitis include inflammation of the spermatic cord, testicle and synovial membranes. **Lymphatic varices:** These may affect the lymph nodes, especially in the groin. They diminish in size on pressure. **Lymph scrotum** is characterised by enlargement of the scrotum with lymphatic varices. **Ruptured lymphatic varices:** Chyluria results from rupture in the urinary tract. The urine is milky and may contain blood. **Chylous effusions** may form in the peritoneum or in the tunica vaginalis. **The blood:** There is an eosinophilia. The embryos can usually be seen in a wet film taken at night. The common type of tropical eosinophilia is a form of filariasis. **Elephantiasis:** In this condition there is a marked solid œdema, due to lymphatic obstruction. Microfilariæ are absent from the blood. The legs are usually affected, there being an enormous swelling with thickening of the skin and subcutaneous tissues. The scrotum may be involved, forming a tumour weighing over 50 lbs. (24 kg.). The vulva and arms are less commonly affected.

Course and Complications. The disease pursues a chronic course. Cutaneous carcinoma may occur as a complication of elephantiasis of the leg.

Treatment. Prophylactic. Mosquito breeding places should be sterilised, and electric fans and mosquito nets used as for malaria.

Curative. No specific drug is known, but some favourable results have been obtained with diethylcarbamazine (Ictrazan) 50 mg. tab.

It is given by mouth in doses of 0.2 to 2 mg./kg. body weight t.i.d. for about 2 to 4 weeks. Repeated courses may be required.

Acute lymphangitis: The limb should be rested and elevated, and a lotion applied, such as Liq. plumb. subacetat. dil., 4 parts, alcohol 90%, 4 parts, aquam ad 100 parts. Penicillin or sulphadiazine should be given for secondary streptococcal infections.

Chyluria: Fat should be omitted from the diet.

Elephantiasis: An elastic stocking should be worn, and some promising results have been obtained by the Kondol  n type of operation (see p. 295). Operation may be required for elephantiasis of the scrotum.

Loiasis

The adult worm called *Loa loa* is 30 to 35 mm. (1½ inches) long and is slightly thicker than *W. bancrofti*. The embryo is called the *Microfilaria loa* (*diurna*), and is about the same size as that of the *W. bancrofti*. It appears in the peripheral blood during the daytime, and this periodicity cannot be changed by altering the sleeping hours of the patient. Man is infected through the bites of mangrove flies, such as the *Chrysops*. The adult worm produces in man œdematous swellings under the skin (Calabar swelling of West Africa), which take about 3 days to come and go, recurring irregularly. The worms also pass under the skin, and may invade the conjunctiva or anterior chamber of the eye.

Treatment. Diethylcarbamazine (Hetrazan) has a curative effect and removal of the worm from the eye is usually unnecessary.

Onchocerciasis

The adult worm is the *Onchocerca volvulus*. This microfilaria is smaller than the *W. bancrofti*. Man is infected by the bite of the buffalo gnat, *Simulium damnosum*. It is met with in West and East Africa and in South America. The chief lesions are subcutaneous nodules, iritis and blindness. The treatment is by diethylcarbamazine (Hetrazan) when the eyes are involved. The initial dose is 0.1 mg./kg. body weight t.i.d., and each day the amount is doubled until 12 mg./kg. body weight are given daily. This is continued for 2 weeks. This may be followed by a course of suramin (Antrypol). A trial dose of 0.1 G. is given intravenously and the urine examined for protein over the next 24 hours. If there is no adverse reaction 1 G. suramin is given intravenously 5 days later and repeated every 5 days until a total of 6 G. has been given. The urine should be examined for protein, blood and casts before each injection. Antihistamines and corticosteroids may be required for its side effects, such as burning of the eyes or œdema of the skin lesions. The subcutaneous nodules should be excised.

Dracontiasis

(Guinea-worm Disease)

Etiology. Dracontiasis is caused by the nematode *Dracunculus medinensis*. The adult worms are found in man. They measure from

6 inches (15 cm.) to 8 feet (90 cm.) long and about $\frac{1}{20}$ inch (1.2 mm.) in diameter. The embryo worms are present in a small crustacean (*Cyclops*), and man is infected through drinking contaminated water. The worms are liberated in the stomach, enter the intestine, and finally pass to the subcutaneous tissues, increasing in size. The adult female worms penetrate the skin, usually on the arms or legs, and the uterus discharges embryos on to the surface of the skin for about 8 weeks. If the skin is in contact with water, as is usually the case, embryos pass into the water and then again into the *Cyclops*. The adult worm then dies, and may be discharged from the skin or become calcified, or an abscess may form around it. Locality: Dracontiasis is met with in India, in Egypt near the Nile, in West Africa, Uganda and the East Indies.

Clinical Findings. During the invasion period, before the adult worm has matured, there may be constitutional disturbance with fever, nausea, vomiting and eosinophilia. As the worm works its way to the surface urticaria may develop. An itching or burning spot may then be noted at which a blister forms. This ruptures and the head of the worm may be seen. The embryos are discharged, as described above.

On Examination: The adult worm can usually be seen or felt beneath the skin.

Treatment. *Prophylactic.* Small fishes can be placed in water supplies to eat the infected *Cyclops*. Water used for drinking or for washing food utensils should be sterilised by boiling.

Curative. The worm may be extracted by injecting with procaine anaesthesia an emulsion along the course of the worm. This results in relaxation of the worm so that it can be removed by traction. The emulsion consists of phenothiazine 2 G., lanolin 0.85 G., olive oil 85 ml. and sterile water 5 ml.

Toxocariasis

The disease is caused by the *Toxocara canis*, the dog round worm: the *T. cati* infects cats.

It may cause blindness in children and encephalitis in adults. There is eosinophilia and a positive skin test. It is said that 20% of cats and dogs in the South of England are *toxocara* carriers. This suggests that cats and dogs should be regularly de-wormed.

It is given by mouth in doses of 0.2 to 2 mg./kg. body weight t.i.d. for about 2 to 4 weeks. Repeated courses may be required.

Acute lymphangitis : The limb should be rested and elevated, and a lotion applied, such as Liq. plumb. subacetat. dil., 4 parts, alcohol 90%, 4 parts, aquam ad 100 parts. Penicillin or sulphadiazine should be given for secondary streptococcal infections.

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Differential Diagnosis. The history of the case and clinical picture render the diagnosis obvious. In some cases the patient is first seen in coma, and in others the condition may suggest an acute abdominal lesion.

Course and Complications. Unless adequate treatment is given at once, permanent nervous damage or death may ensue. Secondary hæmorrhage may occur in the affected tissues. Chronic arthritis and aseptic bone necrosis may develop as complications.

Prognosis. This depends entirely upon the severity of the condition and the means available for early treatment.

Treatment. Prophylactic. Fat men, and those suffering from diseases of the heart, lungs or kidneys, or men addicted to alcohol must not be employed as caisson workers. Inflammation of the auditory tubes is also a contra-indication, as there is a risk of rupture of the tympanic membrane owing to inability to equalise the pressure in the middle ear by swallowing movements during the time the external pressure is being raised. Men should not work longer than a 1 hour shift at a pressure of $+ 50$ lb. (22.7 kg.); longer shifts are permissible for lower pressures. When working at increased pressures, decompression must be gradual. The men pass through a series of air-locked chambers, where the pressures are gradually lowered, a due stay being enforced in each chamber. Exercise and the inhalation of oxygen are also important during the decompression. Those who wish to partake in deep sub-aqua diving should be very thoroughly examined before indulging in this pastime. The presence of varicose veins, chronic skin disease, recent abdominal operations, peptic ulcers, kidney disease, high blood pressure, diminished lung capacity, claustrophobia, a carious tooth, lung disease, a history of fits, middle ear disease etc., and the absence of incisor teeth by which the mouth-piece of the breathing apparatus is held, are contra-indications.

Curative. The patient should be placed in a chamber ("medical air lock"), and the pressure raised to that at which he was working. After half an hour he is very gradually decompressed. If no chamber is available, the patient may be lowered to the pressure at which he was originally working, and gradually brought to the surface. If this is not feasible oxygen and morphine should be administered. The plasma-volume deficit may be corrected by an intravenous injection of a 5% albumin solution, 100 to 150 ml./hr.

Mountain Sickness

(Anoxæmia)

Definition. Illness resulting from exposure to a low barometric pressure.

Etiology. Mountain sickness results from ascents to great heights, usually over 12,000 feet (3,600 metres), as in climbing or flying.

Pathology. There is a deficient supply of oxygen to the blood. Compensatory changes may occur, such as increase in the number of red cells in the blood (erythrocytosis): there are no nucleated red cells,

CHAPTER XVI

DISEASES DUE TO PHYSICAL AGENTS

Caisson Disease

(Compressed Air Illness. Diver's Palsy)

Definition. A disease due to sudden reduction of atmospheric pressure.

Etiology. This is a disease of workers in caissons, who are exposed to compressed air when employed as divers or as builders of bridges, tunnels or skyscrapers. There is usually no risk unless the pressure is increased by more than that of one atmosphere i.e. $+ 15$ lb. per square inch (1.054 kg./sq. cm.). The atmospheric pressure is doubled at a depth of 33 feet (10 metres), trebled at 66 feet (20 metres) and quadrupled at 99 feet (30 metres). The danger is intensified by the length of exposure to the increased pressure. Thus divers are less often affected, because, although when they go to a great depth the pressure in their helmets is high, they work at such a pressure for only short periods. The symptoms appear on decompression on return to the surface. It also affects people flying at 30,000 feet (9,000 metres) or over.

Pathology. The increased pressure in the caisson causes excess of oxygen and nitrogen to be taken up by the blood. The oxygen combines with the tissues and does no harm. The nitrogen is also absorbed by the tissues, especially by fat and by the central nervous system, and after a time the blood is completely saturated with nitrogen. If the pressure is now rapidly reduced, as the worker comes to the surface, the nitrogen is liberated from the tissues in the form of bubbles; these bubbles may appear in the fatty tissues, spinal medulla (cord), brain, intestines, and also in the blood. Thus the capillaries may be obstructed by gas emboli or the heart filled with gas. Permanent damage may be done to tissues by thus cutting off their blood supply. Fat people absorb more nitrogen and so are more prone to the disease. Post-mortem: Numerous gas bubbles may be seen in the brain, the spinal medulla (cord), especially in the lower thoracic portion, in the subcutaneous tissues, the heart, and in certain viscera, such as the liver.

Clinical Findings. In decompression sickness or dysbarism the patient usually gives a history of a rapid return to the surface from a depth, and notices symptoms about $\frac{1}{2}$ to 3 hours later. In mild cases there is headache with pains in the joints, especially the knees and ankles, and in muscles (the "bends"). The "bends" may also occur in deep sub-aqua diving, in which the breathing apparatus fails and the diver surfaces too rapidly. The legs are usually affected and the joints are kept flexed. In more severe instances there is giddiness (the "staggers"), abdominal pain, nausea, vomiting, shortness of breath (the "chokes"), intense itching of the skin (the "itch"), and paralysis, usually paraplegia, or collapse and death may rapidly ensue. This may be associated with hæmoconcentration due to a plasma-volume deficit.

sugar at the earliest appearance of symptoms. Fats should be avoided. As a prophylactic a Marzine (cyclizine hydrochlorid.) tab. 50 mg. may be taken half an hour before departure, and repeated if necessary one to three times daily.

Heat-stroke

(Sunstroke. Heat Hyperpyrexia)

Definition. Illness resulting from exposure to the sun.

Etiology. Heat-stroke usually results from exposure to the sun. It generally occurs in the tropics, when the shade temperature reaches 110° F. (43.3° C.). White races are very susceptible. *Predisposing causes:* Debility from other diseases, alcoholism and constipation. There is often an associated infection, such as a boil, malaria or gastro-enteritis.

Pathology. The heat-regulating mechanism is disturbed. Post-mortem, the right heart is dilated and there is œdema of the central nervous system.

Clinical Findings. The patient gives a history of exposure to sunlight. He is suddenly taken ill with headache, and may vomit and have diarrhœa. The patient collapses and may rapidly become unconscious.

On Examination: The face is flushed, the skin is hot and dry, the pupils are dilated, the pulse and respirations are rapid and the temperature is raised to 109° F. (42.7° C.) or higher. Convulsions may occur. The knee-jerks are absent. The cerebrospinal fluid pressure is usually raised, and there may be an increase first of the polymorphonuclear cells, and later of the lymphocytes. The breathing may become irregular, of the Cheyne-Stokes type, and the pupils are constricted before death.

Differential Diagnosis. A blood film should be taken to exclude malaria.

Course and Complications. Death may rapidly ensue. Complications include dilatation of the right heart and œdema of the lungs. If the patient recovers from coma there may be mental confusion, aphasia, incontinence, and signs of a corticospinal or cerebellar lesion. Complete recovery may ensue, or the patient may show signs of dementia.

Treatment. Prophylactic. The bowels should be kept open daily, plenty of fluid consumed, but alcohol should not be taken to excess. The head, neck and spine should be adequately protected from the sun.

Curative. The temperature is lowered by applying ice to the head, neck and spine, total immersion in ice-cold water, with massage of the extremities, spraying the body with ice cold water, and, if necessary, by giving a rectal injection of ice cold water. At the same time a current of air should play on the body, produced either by electric fans or by flapping towels. When the rectal temperature falls to 102° F. (38.9° C.) these measures must be discontinued. Venesection should be performed if the patient is cyanosed. Lumbar puncture may be required to relieve

but the reticulocytes are more numerous. There is alkalaemia with a fall in the alkali reserve.

Clinical Findings. In rapid flying ascents to over 25,000 feet (7,500 metres) death may occur, after a preliminary stage of dulling of all the mental faculties, followed by muscular paralyses. In more gradual ascents the patient complains of headache, muscular weakness, giddiness, palpitations, dyspnoea, nausea, vomiting and fainting attacks. He appears cyanosed.

Treatment. A portable oxygen apparatus should be used at high altitudes.

Sea-Sickness

(including Train, Car and Air Sickness)

Definition. Sickness occurring on the sea, in a train, a car, or an aeroplane.

Etiology. There are various theories as to the causation of these varieties of sickness, such as: Labyrinthine, ocular or splanchnic disturbances; a neurosis, resulting from auto-suggestion; acidosis and hypoglycaemia. Train, car and air sickness are probably closely allied conditions. *Predisposing causes:* 1. Age: Infants and the aged are immune, all other ages are susceptible. 2. Those subject to migraine or suffering from diabetes mellitus or nephritis, and pregnant women are especially liable.

Pathology. It has been shown that before vomiting occurs there is an increased output of ammonia in the urine, with acetone bodies. There is also a preliminary hyperglycaemia followed by hypoglycaemia. Acidosis is more severe when the vomiting stage is reached.

Clinical Findings. The unfortunate victim feels squeamish, with a tendency to yawn and salivate. He may have headache and disturbance of vision, such as diplopia. The vomiting is usually ushered in by more profuse salivation; in severe cases there is marked collapse, the sufferer loses interest in life and wishes for a speedy end to his torments. The face is pale or greenish, the skin is cold, the pulse rapid and blood pressure low. The output of urine is diminished and diarrhoea or constipation may occur.

Differential Diagnosis. It is important not to overlook any abdominal condition, such as acute appendicitis, intestinal obstruction or a perforated gastric ulcer. Attention must be paid to the presence of abdominal rigidity in organic abdominal lesions and alterations in temperature and pulse rate should be recorded on an hourly chart. The result of enemas is of diagnostic value in intestinal obstruction.

Course and Complications. Some individuals are never able to overcome sea-sickness; in others accommodation is rapidly established. Concentration of the urine may lead to bladder irritability, resembling that due to cystitis.

Prognosis. Sea-sickness is never fatal; pregnant women do not miscarry.

Treatment. A meal rich in carbohydrate should be taken before the voyage, and the blood sugar kept up subsequently by eating lump

Pathology. Severe cold produces peripheral cutaneous vasoconstriction, followed by liberation of H-substance, vasodilatation, damage to vessels and transudation of fluid into the surrounding tissues. This results in œdema and bulla formation. In more severe cases of frost-bite thrombosis and gangrene ensue. The effect of high altitude and oxygen-lack is an increase of pulse rate up to 180 to 250 per minute, with a reduction in the output (minute-volume) of blood from the heart.

Clinical Findings. Frost-bite may occur very rapidly, e.g., if a metallic object is touched by the tip of a bare finger in severe cold or at a high altitude. In other cases, where the exposure is more prolonged, as may happen when tramps sleep out in the winter, there is first a feeling of burning in the extremities followed by a lack of all sensation. The onset of trench foot is much more insidious, taking often days or weeks.

On Examination : Various stages of frost-bite may be seen, such as a white and waxy appearance of the skin in mild cases. In more severe ones the skin is red or almost black, with bulla formation and gangrene. Trench-feet are usually bluish-red. Varying degrees of hypoaesthesia to light touch, pin-prick and temperature sensation are present in frost-bite and trench foot.

Course and Complications. Pain is experienced in the extremities as recovery takes place. The nails may be shed or portions of the extremities lost by gangrene.

Treatment. Prophylactic. Protection by means of adequate clothing, dry gloves and ear-flaps, is important. Properly designed clothing, including footwear, based on experience gained by polar expeditions, high-altitude flying, etc. will do much to protect servicemen and others who have to face exposed conditions. The object is to keep the body temperature as near normal as possible.

Curative. If a foot or hand becomes numb or the nose goes white, the affected part should be warmed by taking off the boot or glove and placing the limb between the thighs or under the arm of a comrade. The nose should be warmed between the hands. In more advanced cases local application of heat in any form must be avoided, and friction, which includes rubbing with snow, must, on no account, be applied to the affected parts. These should be cleaned gently, using gauze soaked in 1/1,000 proflavine, then carefully dried. Open exposure is better than dressings. Bullæ which have burst or gangrenous areas should be dusted with sulphathiazole powder. General treatment consists in combating shock by the administration of hot drinks. If the body temperature is subnormal the bed should be warmed with hot bottles, which must not be placed near the affected parts. Prophylactic injections of tetanus toxoid should be given and anticoagulants (see p. 191) to minimise the risk of thrombosis. Antibiotics should be used to prevent infection. In cases developing at high altitudes the administration of oxygen is of great value. Sympathectomy may prevent gangrene.

increased cerebrospinal fluid pressure. An intravenous injection of quinin, dihydrochlor. 10 gr. (0.6 G.) in 20 ml. of distilled water should be given slowly if there is any doubt as to the condition being due to malaria.

Heat Exhaustion and Heat Cramp

Definition. Illness resulting from exposure to heat.

Etiology. Heat exhaustion is prone to develop in hot moist atmospheres, when evaporation from the skin is low. Heat cramp results from exposure to dry heat, the excessive sweating leading to diminution of the blood chlorides. Stokers, miners, and iron and steel workers are subject to heat exhaustion, without any direct exposure to sunlight.

Clinical Findings. The patient has usually been working in a very hot atmosphere, such as that which a stoker must endure. He becomes weak, giddy, and may sweat and collapse. In some instances there is vomiting and diarrhoea, or painful cramps may be felt in the legs.

On Examination: In heat exhaustion the patient is usually pale owing to vaso-constriction, the skin is moist and the oral temperature may be subnormal, whereas the rectal temperature is raised to about 102° F. (38.9° C.). The skin and subcutaneous tissues show evidence of dehydration. In more severe cases there is marked shock, the pulse is frequent and feeble, and unconsciousness may ensue. The blood pressure is low. Uræmic symptoms may result from renal anoxia. The urine output is low, the urine may contain casts and the sodium chloride content is much reduced. Heat cramp may also occur in temperate climates.

Treatment. The patient should be moved to a cool place and treatment directed to correcting the dehydration, sodium chloride loss and shock. A careful record should be kept of the fluid intake and output, and the urinary chlorides estimated every 8 hours. In severe cases an intravenous injection of normal saline should be given, 1,000 ml. or more, according to the dehydration and chloride content of the urine. Half normal saline may also be given by mouth or by nasal intra-gastric drip. Heat cramp may be prevented or relieved by drinking 0.1% sod. chlorid. solution in orangeade, or by taking by mouth tablets of sod. chlorid., 15 gr. (1 G.), up to 15 or 20 in the day.

Frost-Bite

Definition. The harmful effects produced by cold on peripheral parts of the body. Under the term the cryopathies are included frost-bite, immersion foot and hand, trench and shelter foot.

Etiology. Frost-bite results from exposure to severe cold, especially if the individual is in a high wind or is at a great altitude. Trench foot is a variety of frost-bite. The causative factors here are cold, not necessarily of a severe degree, stagnation of circulation due to standing in wet and muddy trenches, ill-fitting boots and tight clothing on the legs.

CHAPTER XVII

THE POISONS

Introductory. Acute poisoning is usually due to substances taken by inhalation or by mouth, rarely by injection. To rid the body of swallowed poisons, which have not yet been absorbed, gastric lavage is of the greatest value. Emetics should only be given if the requisites for gastric lavage are not available. Purges are seldom required. Gastric lavage is contraindicated if strong corrosives, such as strong nitric, sulphuric or hydrochloric acid, caustic potash or soda, or strong ammonia have been swallowed. In such cases the corrosive should be neutralised. Strong acids can be neutralised with four tablespoonfuls (60 G.) of light or heavy magnesia to a pint (600 ml.) of water, half a pint (300 ml.) being used for a child. To neutralise strong alkalis six tablespoonfuls (90 ml.) of vinegar or the juice of six lemons are added to a pint (600 ml.) of water.

Very thorough lavage should be given, using 2 gallons (9.6 litres) of warm water. Great care should be taken to prevent the fluid from regurgitating into the lungs. The patient is placed prone with his head hanging over the end of the couch or bed, the forehead being supported by an assistant. A Jaques' firm rubber stomach tube (oesophageal tube), size 23-30 English catheter gauge, 60 inches (150 cm.) long is used for an adult. If emetics are required a subcutaneous injection of apomorphin. hydrochlor. $\frac{1}{10}$ gr. (6 mg.) will produce vomiting in 5 minutes. Other emetics which may be used include mustard or salt $\frac{1}{2}$ oz. (15 G.) in a tumbler (240 ml.) of warm water.

Mercury Poisoning

Etiology. Mercurial poisoning may occur: 1. As an occupational disease, in miners of mercury, thermometer, barometer or looking-glass makers, and felt hat makers who use mercury nitrate. 2. If mercury (usually the perchloride) is taken for suicidal or homicidal reasons. 3. In accidental contamination of foods or by accidentally drinking perchloride of mercury. 4. In the therapeutic use of mercury, due to gradual overdosage or personal idiosyncrasy.

Pathology. In acute poisoning there is found post-mortem intense inflammation of the mucous membrane of the stomach and intestines. The stomach mucous membrane may be greyish white, and a greyish membrane may form in the large intestine. The kidneys show the changes of acute tubular necrosis.

Clinical Findings. *Acute Poisoning.* This usually results from taking perchloride of mercury solution by mouth, either accidentally or suicidally, or by using it as a vaginal douche. Within a few minutes of ingestion there are severe epigastric pains and vomiting. The vomit

Electric Shock and Burns

Definition. The harmful effects produced by electric currents.

Etiology. Electric shock is usually accidental, as by contact with a live wire on an electric railway, by touching an electric heater when in a bathroom, or by contact with a house lighting system. Death in the bathroom is due to a fault in the electric system, whereby some of the current is entering the switch. The victim is usually in the bath, which acts as a condenser, and on switching off the heater his body is subjected to a high current. The result is not usually fatal with voltages under 800 for the direct current, or under 100 with an alternating current. Very high voltages of alternating current, on the other hand, may do little or no harm. Lightning may cause electric shock, and burns may occur from X-rays or diathermy used in medical treatment. In the lightning flash there is a rush of protons and electrons through the air, the current is direct, and the voltage very high, 1,000 million volts or more.

Pathology. The body is often charred locally, the blood is fluid and small hæmorrhages may be found in the brain. The heart may be arrested by ventricular fibrillation; this causes death in 90% of cases. In death from lightning an effusion is found under the scalp, without any superficial abrasion. Burns of varying degree are seen on the body.

Clinical Findings. The patient is often killed outright. The lightning flash may burn the skin, the blast resulting from the decompression and compression force of the air displaced around the flash may cause the clothes to be stripped from the body, or the lungs to be ruptured. In other cases the victim is rendered unconscious, but slowly recovers, experiencing great pain as the circulation is restored. In slighter degrees of electric shock the patient who has gripped a live wire is unable to relax his hold, is terrified and feels severe pain. Electrical burns of all kinds are very slow in healing. Proteinuria may be noted subsequently, due to the presence in the blood of abnormal protein substances.

Treatment. The current should be switched off and the patient removed. If the current cannot be cut off, the hands of the rescuer should be protected by rubber gloves or some dry, thick material. He should also stand on a dry substance, such as bricks or cloth. Artificial respiration should be applied for several hours if the patient is unconscious. In addition nikethamide (Coramine) 10 ml., should be injected intravenously.

occupational disease. The following are the chief causes: 1. *Occupations*: Workers in red and white lead, painters, potters, brass founders, miners, rubber mixers, accumulator manufacturers and printers, and those engaged in the manufacture of tetra-ethyl lead and in blending it with petrol. 2. *Food*: Soft water may be contaminated by lead pipes, beer may be similarly affected, cider may be tainted by lead glaze in jars, and wine by subacetate of lead added as a sweetening agent. Tinned foods may cause poisoning, especially oily fish in soldered tins, and illness has resulted from eating cakes coloured yellow with lead chromate. 3. *Cosmetics*: Hair dyes, toilet powders or face creams may contain lead. 4. *Drugs*: Ointments containing lead may cause poisoning when applied to broken surfaces, or lead lotions used as an eye or vaginal douche. Lead pills made from diachylon plaster, were formerly used to obtain abortion, but the sale has been checked by the Poisons Act. Lead tetra-ethyl can be absorbed through the skin, and the vapour given off is absorbed freely through the lungs, and, owing to its fat-soluble properties, it poisons especially the central nervous system. 5. *Toys*: If the paint contains lead. An infant may bite the lead-containing paint on his cot (see p. 790). *Predisposing causes*: Women and children are more susceptible than men, and negroes than white men. Debility from any acute illness and chronic alcoholism are also predisposing factors.

Pathology. Lead absorbed from the alimentary canal is carried to the liver and may then pass into the systemic circulation or be excreted in the bile. It is conveyed by the blood stream to all the tissues of the body, but is stored especially in the bones. It circulates in the blood plasma as a colloidal phosphate and accumulates in the solid parts of the bones, probably as an insoluble triple phosphate, $Pb_3(PO_4)_2$. It may be liberated from the bones and flood the blood. It is excreted chiefly in the faeces, to a slight degree in the urine, and less still by the skin. Inhaled lead dust is carried direct to the systemic circulation. A slight increase of the acidity or alkalinity of the blood appears to result in liberation of lead from the bones, as does also any agent which causes solution of calcium salts from the bones. *Post-mortem*: Gastro-enteritis is found in acute lead poisoning; in chronic cases nervous lesions such as degeneration of anterior horn cells, peripheral neuritis, and muscular atrophy may be found. The amount of lead present in the skeleton varies between 0.2 and 0.8 G. Such lesions as arteriosclerosis and chronic nephritis are not indubitably due to lead.

Clinical Findings. *Acute Lead Poisoning.* This may be a primary disease caused by a large dose of lead taken with suicidal intent, or accidentally. If a large dose of lead is swallowed the patient suffers from burning in the mouth, thirst, dysphagia, intestinal colic, vomiting, cramps in the legs and convulsions. The bowels are constipated. Acute symptoms or "toxic episodes" may also occur during the course of chronic lead poisoning, and these are described later.

Subacute and Chronic Lead Poisoning. Twenty-five cases of tetra-ethyl lead poisoning, 2 of which were fatal, occurred in this country in 1945, during tank-cleaning operations. The tanks had been used for

may contain blood. Diarrhoea rapidly follows and the stools also may be bloodstained. Prostration and collapse follow according to the severity of the intoxication. The blood : This may show an increase of urea and non-protein nitrogen. The urine : This is highly acid, and may contain protein, blood and casts. Suppression of urine may ensue.

Chronic Poisoning. Therapeutic overdosage with mercury is characterised by salivation, a metallic taste, stomatitis, gingivitis, offensive breath and diarrhoea. The hand-writing shows tremor. In industrial poisoning there may be also headache, lassitude, anæmia, loosening of teeth, proteinuria, a rise of blood pressure and marked tremors of an intentional variety. Mercurial dermatitis, with erythema and desquamation, may appear. Mercurial erythema is sometimes noted, and is characterised by excitability, shyness with strangers, insomnia, depression and giddiness.

Differential Diagnosis. The diagnosis is usually apparent from the history and typical clinical findings. Mercury may be present in the faeces.

Course and Complications. The course depends upon the amount of mercury ingested. Complications include renal tubular necrosis, anæmia and colitis.

Prognosis. This is very grave in acute cases, but has been much improved by modern treatment. Death may occur in a few hours or days. In chronic cases recovery usually results, and depends upon the rapidity of the recognition of intoxication and withdrawal of the poison. Tremors may persist for several years.

Treatment. Acute Poisoning. The stomach should be washed out with 1 gallon (4.8 litres) of a warm saturated solution of sodium bicarbonate, and 8 fl. oz. (240 ml.) of a saturated solution of magnesium sulphate left in the stomach. A soap and water enema should then be given. Alternatively the stomach may be washed out with 250 ml. of 5% sod. formaldehyde sulfoxylate. Dimercaprol (B.A.L.) is then injected in the doses given on p. 556. For relief of the abdominal pain and diarrhoea tnc. opii 30 m. (2 ml.) should be given 2 or 3 times daily.

Chronic Poisoning. Prophylactic. Workers in a dangerous occupation should be subjected to periodical medical examinations. When mercury is being administered a watch should be kept constantly for early signs of mercurialism.

Curative. The mercury administration must cease, or the worker be removed from exposure to the poison. Elimination is aided by administering mag. sulph. 60 to 120 gr. (4 to 8 G.) daily. For mercurial dermatitis a lotion of 1% sodium hyposulphite should be applied, 4 gr. (0.3 G.) to 1 fl. oz. (80 ml.).

Lead Poisoning

(*Plumbism. Saturnism*)

Etiology. Lead may enter the body through the alimentary tract, it may be inhaled as dust, or absorbed through abrasions in the skin or mucous membranes. Lead poisoning is chiefly of importance as an

red cells per million red cells must be so stippled to be diagnostic. These stippled cells are reticulocytes. The white cells are usually normal. The fæces : These usually contain lead, as does the urine, if lead has reached the blood stream. The cerebrospinal fluid : In the convulsive stage it is under pressure and contains an excess of lymphocytes.

Differential Diagnosis. It should be remembered that the symptoms of plumbism may develop after an individual has ceased to be exposed to lead. Various factors may cause lead to be liberated from the bones into the blood. The diagnostic features are the blue line, the punctate basophilia and the presence of lead in the urine. As traces of lead may be found in the urine in health, due to lead eaten with food, at least 0.1 to 0.3 mg. lead per litre of urine must be present to be diagnostic. The upper limit of lead normally in blood is 40 μ G./100 ml.

Course and Complications. The course is characterised by the "toxic episodes" described above. Complications include such conditions as arteriosclerosis, chronic nephritis and gout.

Prognosis. Recovery is apt to be slow. Colic usually rapidly responds to appropriate treatment, paralyses tend to persist unless exposure to lead is stopped at the earliest symptom, recovery occurring first in the muscles last affected. Death is especially liable to occur in maniacal cases.

Treatment. Prophylactic. Measures should be taken to prevent workmen inhaling lead dust ; these include the use of wet processes and the employment of adequate fans and respirators. Workers in lead should wash their hands before eating and change their clothes on leaving work. Periodical medical examinations, at least monthly, should be held to detect early signs of plumbism, and any suspicious cases suspended from work and kept under observation. The urine should be examined for its lead content. If the lead rises to between 0.15 and 0.25 mg. per litre it is probable that poisoning is taking place. A high calcium diet, such as one containing one to two pints (600 to 1,200 ml.) of milk daily, should be taken.

Curative. In acute poisoning, accidental or suicidal, the stomach should be emptied by an emetic such as mustard, $\frac{1}{2}$ oz. (15 G.) in $\frac{1}{2}$ pint (800 ml.) of warm water, or preferably washed out with 2 gallons (9.6 litres) of warm water containing 2 oz. (60 G.) of mag. sulph., and a saline aperient is then given, such as Mag. sulph., sod. sulph. $\overline{\text{aa}}$ 240 gr. (16 G.), acid. sulph. dil. 80 ml. (2 ml.), aquam ad 10 fl. oz. (300 ml.). 10 fl. oz. (300 ml.) to be taken every 4 hours until the bowels are thoroughly evacuated. For abdominal colic hot flannels should be applied locally and an intravenous injection given slowly of 10 ml. of 20% calcium gluconate. In the acute exacerbations of chronic lead poisoning efforts are directed to retain lead in the bones by giving a diet rich in calcium, such as milk 4 pints (2.4 litres) in 24 hours together with calcium lactate 80 gr. (2 G.) t.d.s. by mouth.

Lead can be removed from the body and excreted in the urine by the intravenous injection of sodium calcium edetate (Calcium Disodium Versenate) 0.5 to 0.75 G. per kg. body weight every 12 hours. The drug is introduced into 300 ml. 5% dextrose solution for each intravenous

storing aviation petrol, the sludge at the bottom of the tanks containing organic lead compounds. Further, the majority of the tanks were underground. The early symptoms were difficulty in getting to sleep, troubled dreams, a nasty sweet taste, halitosis, anorexia, diarrhoea with or without abdominal pain, trembling, giddiness and loss of weight. There was no basophilic stippling of the red cells. In other cases the worker complains of lassitude and dyspnoea on exertion. He becomes constipated, loses his power of concentration, has vague pains in the arms and shoulders and loses weight. Cramps may occur in the legs. Periodically acute symptoms, known as "toxic episodes," may occur. Thus the subject of chronic plumbism may have severe intestinal colic. This usually follows a period of marked constipation; the pain is generally hypogastric, and may last for several days. Cramp may also be acute in the legs, bladder or uterus, with menorrhagia or abortion if the patient is pregnant. Acute nervous symptoms such as mania or convulsions, coma or delirium may develop, due to a meningo-encephalopathy. Other nervous lesions may ensue more insidiously, such as optic neuritis and optic atrophy with resulting blindness, or the worker may experience difficulty in using the muscles especially concerned with the performance of his duties. Temporary blindness may result from retinal vascular spasm. Uræmic symptoms may be due to renal anoxia secondary to vascular spasm.

On Examination: The patient is pale and the skin has a greyish tinge. The teeth are often carious and pyorrhoea is present. A blue line may be seen on the gums adjacent to carious teeth or on the mucous membrane of the cheek or lips opposite the bad teeth. It was described by Burton in 1840. This line consists of a series of blue-black dots, best seen with a hand lens, situated just below the margin of the gums and in the subepithelial tissue. It is due to lead sulphide, the H_2S being formed by putrefaction in the mouth. Tremors of the tongue and hands may be noted. Peripheral nerve lesions are generally bilateral. They include: Antebrachial paralysis, with wrist drop, due to paralysis of the posterior interosseous branch of the radial nerve; the supinator muscle is therefore spared. Aran-Duchenne paralysis, with wasting of the small muscles of the hand and thenar and hypothenar eminences, a "claw hand" resulting. Brachial paralysis, the biceps, supinator, brachialis and deltoid muscles are affected. Peroneal paralysis, with foot drop and paralysis of the peroneal muscles, extensor digitorum longus and extensor hallucis proprius. Recurrent laryngeal nerve paralysis, with adductor cord paralysis, may occur. In some instances there is a diffuse muscular paralysis and in others a cerebellar ataxia appears. Sensory changes are generally absent. The reaction of degeneration is obtained in the affected nerves.

Examination of a Patient during an Attack of Colic: The pain is obviously very severe, the patient is pale, sweating and holds his hand to his abdomen, as pressure affords some relief; the abdominal wall is not really rigid and is hollow rather than distended. The temperature is subnormal and the pulse slow. The blood: There is an anæmia. The red cells show "stippling" (punctate basophilia) and at least 100

is soon followed by a burning sensation in the epigastrium. He feels sick and vomits. Intestinal colic and severe diarrhoea usually follow and there may be cramps in the legs. Small amounts of blood may be present in the vomit or the stools.

On Examination: In a severe case the patient is cold and collapsed, the pulse rapid and of small volume.

Chronic Poisoning. The symptoms here are insidious. In the early stages there is irritation of the nasal and conjunctival mucous membranes and later of the pharynx and larynx. If arsenic is being given as medicine these symptoms should be a sufficient warning of an overdose. Further administration of arsenic leads to abdominal discomfort, loss of appetite, nausea, vomiting, tetany, intestinal colic and diarrhoea. The tongue has a silvery white fur. There is a generalised pigmentation of the skin, especially in the flexures where ulceration may occur. Keratosis may develop on the soles and palms. Arsenical neuritis causes pains in the legs and arms, cramps and paresis of the legs. Herpes simplex may develop. Sudden blindness due to optic atrophy may occur with sodium aminoarsenate (Atoxyl), or tryparsamide. Arsenic may be found in the urine, faeces and vomit and also in the nails or hair.

Differential Diagnosis. In general practice it is a delicate matter to reveal one's suspicions of arsenic poisoning, but it is the duty of the doctor to have the urine, faeces, nails or hair examined in any doubtful case. Acute arsenical poisoning may be mistaken for cholera or other forms of acute gastro-enteritis. Chronic arsenical poisoning may be mistaken for gastro-enteritis, colitis, carcinoma of the stomach or Addison's disease.

Course and Complications. These depend on whether or not arsenic is continuously administered. In progressive cases death usually occurs from heart failure with ascites and oedema.

Prognosis. If fatal, death from acute arsenical poisoning usually occurs in a few hours or days. The prognosis in chronic cases depends upon the recognition of the disease and the cessation of the administration of arsenic.

Treatment. Acute Poisoning. The stomach should be emptied by giving an emetic, such as mustard $\frac{1}{2}$ oz. (15 G.) in $\frac{1}{2}$ pint (300 ml.) of warm water until vomiting occurs, or preferably by gastric lavage. Freshly prepared ferric hydroxide should be used in gastric lavage, as this forms an insoluble arsenite. It is made by adding sod. bicarb. to liq. ferri perchlor. 2 fl. oz. (60 ml.) until effervescence ceases. The precipitate of ferric hydroxide is filtered off and added to 2 gallons (9.0 litres) of warm water. An aperient should be given after an hour consisting of mag. sulph. 240 gr. (10 G.) in half a tumbler of water (120 ml.). General treatment consists in keeping the patient warm, administering stimulants such as nikethamide (Coramine) 2 ml. intramuscularly, and if the abdominal pain is very severe a hypodermic injection of morphin. sulph. $\frac{1}{2}$ to $\frac{1}{4}$ gr. (10 to 15 mg.) may be given. Dimercaprol (B.A.L.) should be given both for acute and chronic arsenical poisoning, in doses recommended on p. 556.

injection. Four or five courses, each lasting 3 or 4 days are given. The resulting anæmia should be treated with iron or by blood transfusion.

Lead Poisoning in Children

This is most often due to paint containing lead, applied either to the child's cot or to toys, which the infant sucks. The child may swallow flakes of paint detached from the walls, or he may suck yellow crayons containing lead. In children lead is liable to remain in the bones, giving rise to recurrent episodes of poisoning.

The child's brain may be affected leading to encephalopathy, or he may be mentally retarded. Other indications of lead poisoning include anæmia, convulsions, renal glycosuria, aminoaciduria and abdominal pains.

Examination shows microcytic anæmia, punctate basophilia, coproporphyrinuria, and an increase in the pressure of the cerebrospinal fluid and of its protein content. The urine may have a lead content of over 0.1 mg./litre, and the lead in the blood may be over 40 μ G./100 ml. X-rays of the long bones may reveal lines of increased density near the growing ends.

Treatment. Sodium calcium edetate (Calcium Disodium Versenate) causes increased elimination of lead in the urine. It may be given by mouth to children. The tablets contain 0.5 G. and the dose is 75 mg./kg. body weight given in divided doses six hourly for 7 days.

Arsenic Poisoning

Etiology. Arsenical poisoning may be due to: 1. Occupations such as extracting white arsenic from arsenical pyrites or preparing sheep-dip. Arsine may be inhaled in chemical works or in submarines, where it is liberated from battery plates. 2. Administration of arsenic with homicidal or suicidal intent. Weed-killers, fly-papers or rat pastes may be used. 3. Food-stuffs accidentally contaminated, such as glucose in the preparation of beer, the sugar covering sweets, and the skin of apples which have been sprayed with an arsenic solution as a parasiticide. 4. Therapeutic administration of arsenic, either due to an overdose being given or to idiosyncrasy of the patient. It may occur with such preparations as Fowler's solution (liq. arsenicalis. B.P.), sodium cacodylate, sodium aminoarsenate (Atoxyl), tryparsamide or neoparsphenamine.

Pathology. In acute cases there is inflammation of the mucous membrane of the stomach and upper part of the small intestine, and cloudy swelling may be found in the liver, heart and kidneys. In cases of chronic poisoning fatty degeneration is present in most of the organs of the body. Arsenic can be detected in the body for many months after death.

Clinical Findings. *Acute Poisoning.* Directly after taking a poisonous dose the patient experiences dryness in the throat, and this

On Examination : The breath smells of alcohol, the face is usually flushed but may be pale, the skin is moist, the pupils dilated and the pulse rapid and bounding. There may be lateral nystagmus. The speech may be slurred or over-precise, and there may be difficulty in pronouncing certain words or in counting backwards. Co-ordination may be impaired as shown by the finger-nose test and inability to walk steadily along a line. In alcoholic coma the pupils are constricted, the respiration is slow, the pulse feeble, the body temperature subnormal, the limbs flaccid, the deep reflexes diminished and the plantar response is flexor. The urine: The amount of alcohol present in the urine has been suggested as a medico-legal test for drunkenness. It is said that no man whose urine contains 80 mg. alcohol per 100 ml. is fit to drive a car. The alcohol in the urine bears a direct relationship to the alcohol content of the blood. The value of the estimation of the amount of alcohol in the breath as a test for drunkenness is doubtful.

Differential Diagnosis. Drunkenness must be distinguished from : Excitement due to other causes. Coma due to other causes, such as hypoglycæmia after a dose of insulin. The presence of disease or injury in a person who has taken a small amount of alcohol.

Course and Complications. In the majority of cases the patient recovers after a night's rest, but alcoholic coma and pulmonary oedema are always causes of great anxiety. Nephritis or pneumonia may ensue when the patient is exposed to cold, of which he is unaware.

Prognosis. This is usually good, but death may occur in coma from respiratory or cardiac failure.

Treatment. In the majority of cases no treatment is required beyond an aperient, a night's rest in bed and aspirin 10 to 15 gr. (0.6 to 1 G.) to relieve the subsequent headache. In severe cases the patient should be given an emetic $\frac{1}{2}$ oz. (15 G.) mustard in $\frac{1}{2}$ pint (300 ml.) of warm water, or preferably gastric lavage should be performed with 2 gallons (9.6 litres) of warm water containing sodium bicarbonate 1 oz. (30 G.) to a pint (600 ml.), and a pint (600 ml.) of hot coffee left in the stomach. Collapse may be further treated by an electric cradle, hot bottles and stimulants such as nikethamide (Coramine) 2 ml. intramuscularly, amphetamine sulph. 10 mg. in 1 ml. of isotonic saline intravenously, and the intramuscular injection of ephedrine sulph. $\frac{1}{2}$ gr. (30 mg.). If the patient is comatose inhalation of 10% CO_2 and 90% oxygen helps to wash out the alcohol and to oxidise it. This treatment usually restores the patient to consciousness in half an hour.

Chronic Alcoholic Poisoning

Pathology. Post-mortem there may be fatty infiltration and degeneration of the heart, atheroma of the aorta, fatty infiltration and cirrhosis of the liver, dilatation of the œsophageal veins, atrophy of the gastric mucous membrane, chronic nephritis of varying types, congestion of the meninges, excess of fluid in the pia-arachnoid space ("wet brain"), degeneration of cortical motor cells and peripheral neuritis.

In chronic poisoning, after discontinuation of the arsenic, the treatment is symptomatic for the debility and neuritis.

Cyanide Poisoning

Etiology. Potassium cyanide may be taken with suicidal intent, or hydrocyanic acid fumes may be inhaled in fumigation, or cyanide contamination occur in manufacturing processes.

Clinical Findings. When taken by mouth death may occur in a few minutes or not for an hour or so, according to the amount ingested. In some cases the patient recovers, but is left with permanent damage to the central nervous system.

Treatment. Capsules of amyl nitrite should be inhaled. An intravenous injection of 10 ml. of 8% solution of sodium nitrite should be given, taking 4 minutes over the injection. This is immediately followed by the intravenous injection of 50 ml. of 50% sodium thiosulphate solution, taking 20 minutes over the injection. The stomach should now be washed out with a 25% solution of sodium thiosulphate, and 10 ml. of nikethamide (Coramine) injected intramuscularly. The injections should be repeated in 1 to 2 hours should the patient be alive.

Alcoholic Poisoning

Etiology. Alcohol in any form may cause symptoms of poisoning. It is usually due to ethyl alcohol, less frequently to methyl alcohol. *Predisposing causes:* 1. Occupation: Public-house keepers, barmen and commercial travellers. 2. Heredity: A neuropathic predisposition. 3. Worry and pain: The habit may persist after alcohol has been ordered by a doctor during illness.

Acute Alcoholic Poisoning

(Physiological Inebriation)

Pathology. Alcohol is rapidly absorbed from the stomach and intestines and passes to the blood and cerebrospinal fluid. Post-mortem there may be hyperæmia of the gastric mucous membrane and of the brain.

Clinical Findings. The patient suffering from acute alcoholic poisoning is drunk, but the definition of drunkenness, from the medico-legal aspect, has not been satisfactorily established. A person is usually considered to be drunk when, as a result of taking alcohol, he is not able to perform with his normal skill or facility the ordinary actions of his life. The higher centres are first inhibited and then the lower. In the early stages there is diminution of cerebral restraint. The individual loses any sense of shyness and may become talkative or emotional. The onset of muscle fatigue is delayed. The finer acts of co-ordination are disturbed, and later there is unsteadiness of gait, inability to walk, and finally coma. In some instances there is no excited stage, but marked depression from the onset.

not be a help. If a "cure" is effected, the patient is liable to relapse if he takes only one drink.

Delirium Tremens

Delirium tremens usually occurs in subjects of chronic alcoholism, either after an overdose or more commonly when their usual allowance is suddenly cut off, as may arise from the patient being put in prison or in a curative institution where the alcohol is suddenly withheld. Shock, such as an accident and a toxic disease, especially lobar pneumonia, when associated with withdrawal of alcohol, are important causes. The delirium begins with nocturnal visual hallucinations. Objects, which usually appear blue, such as snakes, rats or other animals, are imagined crawling on the bed or about the room. The patient is alarmed and often difficult to restrain. Auditory hallucinations of threatening voices are also heard.

Differential Diagnosis. The onset of delirium tremens may closely resemble that of uræmia owing to the presence of convulsions, oliguria, proteinuria and urinary casts. The blood nitrogen figures are, however, usually normal, but may be raised. The temperature may be normal or raised. The condition usually passes off in 2 to 3 days, the patient sleeping soundly; he may, however, pass into a state of muttering delirium which is followed by death.

Treatment. The patient should be kept in bed in a darkened room, and restrained if violent. Sedation is effected by giving chlorpromazine (Largactil) 25 mg. intramuscularly every 3 hours, or paraldehyde 180 m. (12 ml.) by mouth or $\frac{1}{2}$ to 1 fl. oz. (15 to 30 ml.) by rectum. Alcohol should be stopped at once. Good results may follow the intravenous injection of 100 ml. of 50% dextrose solution, accompanied by the intramuscular injection of 20 units of soluble insulin. Aneurine hydrochloride, 100 mg. should be injected intramuscularly daily. Corticosteroids do not appear to be of special value. If there is evidence of congestive heart failure digitalis should be given. The patient should be encouraged to take as much fluid as possible, especially milk.

Methyl Alcohol Poisoning

This is more likely to occur in countries where there is prohibition. The chief symptoms are giddiness, dyspnoea, nausea and vomiting. Optic atrophy is prone to ensue. It is a powerful poison and liable to cause death.

Treatment. The patient should be given 1 fl. oz. (30 ml.) of castor oil and an intravenous injection of a pint (600 ml.) of a 5% sodium bicarbonate solution to combat acidosis. The effect and dosage can be checked by the determination of the alkali reserve of the blood.

Benzene Poisoning

Etiology. Benzene poisoning is an industrial disease, which may occur in distillers of coal tar, manufacturers of benzene mixtures for

Clinical Findings. There are two main types, the sober in which intoxication rarely occurs, and the inebriate in which the patient is seldom completely sober. The patient may complain that the appetite is poor, and there may be morning nausea or vomiting, the stools being rather loose. Hæmatemesis may occur or bleeding from the rectum due to piles. Peripheral neuritis may be the chief complaint. The patient is often a woman, who suffers from tingling or pains in the calves, cramps and weakness of the legs.

On Examination : The patient is often somewhat obese, dilated venules are seen on the face, the conjunctivæ are watery and injected, the tongue is furred and tremulous, the throat congested, and the breath "heavy." The liver may be enlarged and ascites present.

The calves may be tender on deep pressure, and areas of cutaneous anæsthesia may be found over the legs. In the early stages of neuritis the knee-jerks are increased ; later they are diminished or absent. The leg muscles are weak and may be wasted. In some cases, in addition to the neuritis, there are cerebral symptoms which constitute Korsakow's psychosis. The main features are disorientation as regards time and place ; the patient is unable to remember events which have recently happened, such as what he had at his last meal, or may say he has been out for a walk that morning when he has been in bed for several weeks. Variable oculo-motor paralyses and a myotonic pupil may be seen.

There are other cases, especially in secret drinkers, where no localising effects of the alcohol are present, but the patient is unfitted to a varying degree for his work. He is irritable, lacks concentration and his mentality somewhat resembles that of a child. He tries to give up the alcohol but has not sufficient will power.

Course and Complications. The course is usually progressive, the patient becoming more and more a slave to alcohol. Delirium tremens is liable to occur. Pulmonary tuberculosis may follow as a complication.

Prognosis. The outlook is always grave.

Treatment. The patient should be admitted to an institution devoted to the cure of alcoholism and drug addiction. In order to prevent the onset of delirium tremens the alcohol should be "tapered" gradually, and not cut off at once. It is given in definite amounts at fixed intervals, such as every 2 to 6 hours. A reduction of about 2 fl. oz. (60 ml.) may be made every 24 hours, so that at the end of 10 days, no alcohol is taken. During this stage the patient is best in bed and promazine hydrochloride (Sparine) 25 mg. tab., is given in doses sufficient to produce sedation. Disulfiram (Antabuse) may be given in doses of 8 gr. (0.5 G.) a day and, by rendering the patient very sensitive to small doses of alcohol owing to the formation of acetaldehyde, it discourages him from taking it. It must not be given if the patient is suffering from epilepsy, diabetes mellitus, cardiovascular or hepatic disease. Citrated calcium carbimide (Abstem), one 50 mg. tab. once or twice daily has a less serious reaction. Barbiturates should not be given. As soon as possible the patient should take a good mixed diet. Vitamins B and C should also be given. Psychotherapy and hypnosis may or may

minute hæmorrhages may be found in the brain, lungs and other organs. There is usually œdema of the lungs. Bilateral degeneration of the globus pallidus (Kolisko's lesion) and cerebral œdema may be found.

Clinical Findings. Acute Poisoning. The patient is usually discovered unconscious, with stertorous breathing, frothy exudation on the lips, injection of the conjunctivæ, dilated and fixed pupils, a pink colour in the face and lips, a rapid pulse and low blood pressure.

Chronic Poisoning. The symptoms develop insidiously, the patient probably not knowing that he is breathing a poisonous gas, although the carbon monoxide has a faint odour of garlic. He suffers from lassitude, headache, giddiness, palpitations and nausea; there is a failure of mental powers, the patient cannot read clearly, and then finds he is unable to move his limbs. Sensibility to pain is also abolished. There is usually no dyspnoea. 10 ml. of blood should be removed from a vein, and placed in a small tube, corked, and sent to a laboratory for examination for the spectrum of carboxy-hæmoglobin.

Differential Diagnosis. The circumstances in which the patient has worked or is found usually give a good clue to the diagnosis, which is established by detection of carbon monoxide in the blood.

Course and Complications. Death may rapidly ensue, but the course depends upon the degree of saturation of the blood with carbon monoxide. Bronchopneumonia and myocardial degeneration with premature systoles, or muscle necrosis with acute renal failure may occur as complications. Sequelæ include confusional psychoses and a Parkinsonian syndrome.

Prognosis. This is very grave in acute cases unless the patient receives adequate treatment before the carbon monoxide in the blood rises over 50%.

Treatment. Prophylactic. Care should be taken that geysers and stoves have adequate flues, and that motor cars are properly ventilated. In suspected atmospheres a canary in a cage forms a good danger signal, as it is very sensitive to carbon monoxide, and will fall off its perch if exposed to small concentrations of the gas.

Curative. Acute Poisoning. The patient should be taken into the open air and artificial respiration given. As soon as available, oxygen, or, better, oxygen containing 7% of carbon dioxide should be administered through a mask. The administration of CO_2 and oxygen combined will rid the blood of CO four times as quickly as will the inhalation of oxygen alone. Hyperbaric therapy, high pressure oxygenation, the patient being exposed in a special chamber to pure oxygen at a pressure of 2 to 2.5 atmospheres, causes the oxygen to go into solution in the blood and usually produces a rapid result. In the meanwhile the patient must be kept warm and stimulants applied, such as 2 to 10 ml. of nikethamide (Coramine) injected slowly intravenously. After apparent recovery the patient should be kept very still for several days, as movement may cause heart failure. If there are signs of myocardial damage, the patient must be kept in bed for several months.

Chronic Poisoning. Recovery usually occurs rapidly if the patient is placed in a pure atmosphere.

motor cars, in rubber manufacturers and in workers applying paint by the spray process.

Pathology. The post-mortem appearances in acute benzene poisoning resemble those of asphyxia, with hyperæmia of the various organs.

Clinical Findings. Acute Poisoning. This results from inhalation of air containing a high concentration of benzene. The individual becomes dizzy and rapidly collapses, and death may occur in a few hours.

Subacute and Chronic Poisoning. The subject becomes weak and suffers from headache; a severe and progressive anæmia of an aplastic type develops, in which there is a progressive diminution of both red and white cells. Severe hæmorrhages may occur into the skin, and from the nose, mouth, and intestinal and genito-urinary tracts.

Differential Diagnosis. The nature of the patient's occupation, the typical anæmia and leucopenia establish the diagnosis.

Course and Complications. The course is progressive, unless the source of the poison is removed.

Prognosis. This depends upon the concentration of benzene in the air inhaled.

Treatment. Prophylactic. In dangerous occupations adequate ventilation should be enforced. Clothes, gloves and boots must be taken off on leaving work and cleaned at frequent intervals. Baths should be taken daily. Alcohol should be avoided. Workers should be subjected to monthly blood counts.

Curative. In acute poisoning artificial respiration and the administration of oxygen are required. A blood transfusion should be performed in all cases showing marked blood changes or hæmorrhages.

Carbon Monoxide Poisoning

Etiology. Carbon monoxide is present to the extent of about 15% in coal gas. It is also found in fumes from anthracite or charcoal fires, in the exhaust gas of petrol engines, and in the gas ("after-damp") formed in explosions in coal mines. Carbon monoxide poisoning may thus occur as: 1. An industrial accident, in a coal mine explosion, or as an industrial risk in the manufacture of ammonia, the synthetic production of methane, charcoal burning or carbide manufacture. 2. A home accident, from using an improperly ventilated bath geyser, gas-fire, anthracite, charcoal or oil stove in an unventilated room, from incomplete combustion of calor gas (butane), or from the exhaust of a car, whose engine is kept running in a closed garage. 3. A means of suicide, from a gas-oven, a gas-fire, or a car.

Pathology. Carbon monoxide combines with avidity with hæmoglobin in the blood, forming carboxy-hæmoglobin and displacing oxygen. Anoxemia thus ensues. Poisonous symptoms such as malaise and headache may be expected if the blood is 80% saturated with CO. Unconsciousness ensues with 50 to 55% saturation, and in fatal cases the blood is usually about 80% saturated. Some patients die from nervous lesions, even although all CO has been removed from the blood. **Post-mortem:** The face and lips are pink, the blood is cherry red and

are continued until the patient is brought to a "safe state" as shown by a return of muscle tone and reflexes, including the pharyngeal and laryngeal. For a deeply comatose patient the treatment takes about 2 hours. A total dose of about 200 ml. of the bemegride and 20 ml. of the amiphenazole solutions is required in most cases.

In some cases hæmodialysis is life-saving.

Aspirin Poisoning

Etiology. Poisoning is usually the result of an overdose taken with suicidal intentions.

Clinical Findings. There is a latent period before the signs of poisoning appear, which varies with the amount taken. In one case 750 gr. (50 G.) were taken, the latent period being 14 hours, and in another, in which 1,250 gr. (75 G.) were swallowed, toxic signs appeared after 9 hours.

On Examination: The patient is usually sweating freely and there may be exophthalmos. The pulse and respiration rates are raised and the temperature is subnormal. The patient may vomit small quantities of blood-stained fluid. The pupils are small and may be fixed, and the deep reflexes are normal or depressed. There may be mental confusion and the patient may be alternatively violent or drowsy, and complain of irritation of the scalp. In more severe cases the patient sinks into coma and there is extreme air hunger. The urine gives a strongly positive purple ferric chloride reaction and contains salicylates. There may be a trace of protein. The alkali reserve of the blood is reduced, and the blood urea raised.

Prognosis. The prognosis depends upon the amount taken, the patient's susceptibility, and the treatment given. Death has occurred from as little as 5 gr. (0.8 G.), whereas recovery has followed the taking of 1,500 gr. (100 G.). The average lethal dose has been estimated at between 450 gr. (80 G.) and 600 gr. (40 G.).

Treatment. If the patient is so restless that intravenous treatment is difficult, morphin. sulph. $\frac{1}{4}$ to $\frac{1}{2}$ gr. (7.5 to 15 mg.) should be injected subcutaneously. The stomach should be washed out with warm water, containing 5% sod. bicarbonate. If the patient can swallow, sod. bicarb. 30 gr. (2 G.) should be given by mouth every 2 hours. An intravenous injection should be given of $\frac{1}{5}$ N. saline containing 5% dextrose and 20 G. sod. bicarb. in 1,500 ml. Vitamin K (Synkavit), 10 mg., should be injected intramuscularly. The serum potassium should be determined, and, if there is hypokæmia, potassium administered intravenously or by mouth. In adults a serum salicylate level over 100 mg./100 ml. is considered to be an indication for immediate hæmodialysis. In children an exchange transfusion may be required.

Acute Morphine Poisoning

Etiology. Morphine poisoning may result from an accident, an overdose being prescribed or dispensed, or owing to idiosyncrasy on the part of the patient. It may also be taken in an overdose with suicidal

Poisoning by the Barbiturates

Etiology. The barbiturates or diureides include barbitone or Veronal (soluble barbitone), Medinal, Luminal (phenobarbitone), Luminal-Sodium, Dial, Phanodorm, Allonal, Veramon, Amytal, Evipan, Soneryl, Nembutal, etc. They are used as hypnotics, but in overdoses, or owing to personal idiosyncrasies, may produce coma.

Clinical Findings. In coma due to barbiturate poisoning the pupils are usually dilated and react to light (in very severe cases they are contracted and reactionless) and the tendon reflexes are often exaggerated. In some cases there is excited delirium. The urine output is much reduced. The patient may remain in coma for several days before death or recovery takes place. The temperature is high, apart from pulmonary complications, in severe cases of poisoning. Bronchopneumonia usually develops as a terminal event.

Treatment. Prophylactic. The Pharmacy and Poisons Act of 1933, which came into force in 1936, restricts the sale of these poisons, and they can now only be obtained on prescription.

Curative. Gastric lavage is best avoided. Artificial respiration should be applied, and oxygen with 7% CO₂ administered, if there are signs of respiratory failure, and an air passage maintained. Tracheostomy, with mechanical ventilation, may be required. Hyperbaric oxygen treatment is of value, if the facilities are available. For the unconscious patient treatment by urea-induced osmotic diuresis with alkalinisation of the urine has met with good results. A diuresis of 15 to 20 litres a day should be obtained. *The infusion fluid* consists of 50% non-pyrogenic urea in saline sterilised by filtration. *The electrolytic solution* contains 40 mEq. sodium lactate, 12 mEq. potassium chloride, and 18 G. dextrose per litre, heat sterilised. In the first 4 hours 80 ml. of the electrolyte solution and 80 ml. of the urea solution are injected intravenously hourly. The urine output is measured hourly with the aid of an indwelling balloon catheter. There must be a positive fluid balance of at least 1.5 litres/24 hours.

Contraindications to this form of treatment include a patient who is not in coma, prolonged shock, pulmonary oedema and a serum creatinine figure of over 30 mg./litre.

Bemegride (Megimide) is also of value used in combination with amiphenazole (Daptazole). Bemegride is the more active of the two, rapidly restoring a patient from deep coma to a state of light anaesthesia, which is comparatively safe, thus abolishing the need for strict and prolonged medical and nursing attention. Amiphenazole is a synergist to bemegride, and also a good respiratory stimulant. The drugs are given in normal saline, 0.5% bemegride and 1.5% amiphenazole. A 5% intravenous dextrose drip transfusion is set up, the two saline solutions of the drugs are put in separate 20 ml. syringes. Every 3 to 5 minutes 1 ml. of the amiphenazole solution is injected into the rubber tubing of the drip, followed immediately by 10 ml. of the bemegride solution. After each injection the pulse and respirations are counted, the blood pressure is taken, and the reflexes are tested. The injections

regards cleanliness and dress. In some cases as much as 40 gr. (2.4 G.) of morphine are taken daily.

On Examination: The patient may deny taking drugs, or make a frank confession. He may complain of alternating constipation and diarrhœa. The nutrition is usually poor, the complexion sallow, the hands moist and the nails show trophic changes. The pupils are usually small; they may be unequal. The tongue is furred and the breath is offensive. The pulse and respirations are slow. The deep reflexes are depressed, and patchy areas of hyperæsthesia may be present, especially on the soles of the feet. The sexual functions are depressed, the urine may contain a trace of protein. The skin usually shows the marks of hypodermic injections and of old abscesses.

Differential Diagnosis. Whether or not a suspected person is a drug addict can readily be decided by isolating him, so that he is unable to obtain a supply. In an addict symptoms of deprivation appear in a few hours. There is running from the eyes, yawning, sneezing and restlessness. In more severe cases the addict then becomes weak and trembling and suffers great agony. He may have abdominal pain, vomiting, diarrhœa, and collapse, become maniacal or comatose, and finally die.

Course and Complications. The course is usually progressive, as the addict is unable to break the habit, and gradually requires larger doses. He will resort to any subterfuge to obtain it. Complications include intercurrent diseases, such as septicæmia or pneumonia, and homologous serum jaundice if several addicts use the same needle.

Prognosis. The addict cannot cure himself. The prognosis depends upon the duration of the habit, the adequacy of the treatment and the underlying cause. If the latter can be removed, the chance of a permanent cure is greatly enhanced.

Treatment. Prophylactic. The Dangerous Drug Acts have made it more difficult for these habit-forming drugs to be obtained, and they should not be prescribed unless the patient will only need them for a short time, or to relieve suffering in cases of incurable disease.

Curative. Patients should be treated in special institutions by physicians skilled in the appropriate methods. Sudden withdrawal of the drug is still the best method of treating a young person who has only been an addict for a short time. The acute withdrawal symptoms usually subside after 4 to 5 days. During this time sedatives should be administered such as phenobarbitone $\frac{1}{2}$ to 1 gr. (30 to 60 mg.), 2 or 3 times a day. Hot baths and massage are also helpful adjuncts. In cases of long-standing addiction gradual withdrawal is usually necessary. The morphine is reduced in stages, injections being given at regular intervals, the patient not knowing what dose he is receiving, or when injections of saline are finally substituted for the drug. Equal parts of tnc. belladonnæ and liq. ext. hyoscyami may be used, at first 3 to 5 drops in water every hour the patient is awake. The dose is increased to 15 to 20 drops hourly, provided the pupils do not dilate. Sleep is secured by increasing doses of phenobarbitone up to 6 gr. (0.36 G.) at night. Psychological methods form an essential part of the treatment.

intent. Similar effects may result from poisoning with opium, Omnopon, Pantopon, pethidine, Physeptone, heroin, etc.

Clinical Findings. The patient is usually found comatose, with small inactive pupils, depressed reflexes, a cold and clammy skin, feeble pulse and weak respirations.

Treatment. Even if the morphine has been injected, the stomach should be washed out, as it is excreted into the stomach. Two gallons (9.6 litres) of warm water should be used, containing pot. permang. 60 gr. (4 G.). Nalorphine hydrobromide (Lethidrone) is a morphine antagonist. It is put up in ampoules of 1 ml., containing 10 mg. of the drug. In acute morphine poisoning 10 to 40 mg. are injected slowly intravenously or subcutaneously, the dose being sufficient to restore a satisfactory respiration rate. The patient remains drowsy. To stimulate the respiratory centre oxygen, or oxygen and 7% CO₂, should be given, as for carbon monoxide poisoning, together with artificial respiration.

Morphinism

(including Heroinism and Opium Addiction)

Definition. Chronic poisoning from opium or its derivatives.

Etiology. Morphine is taken by injection, heroin by injection, in a linctus or as snuff, opium by mouth or by smoking. *Predisposing causes:* 1. Race: Opium indulgence is common in India, China, Persia and Turkey. 2. Age and sex: A habit is more easily established in women and in young people. 3. Disposition: Morphine addicts often have a psychopathic or neuropathic tendency, but only a small proportion are degenerates. 4. Pain and worry: The drug may have been taken to relieve sciatica, chronic rheumatism, asthma, bronchitis, gastric or duodenal ulcer, for over-work or because of phobias of cancer or insanity. 5. Occupation: Doctors, nurses and pharmaceutical chemists have access to these drugs. A morphine habit is not usually established unless the drug is taken regularly for several weeks or months.

Pathology. There are no characteristic post-mortem appearances, and death is usually due to some intercurrent disease. Often in cases of acute poisoning no morphine can be recovered from the body, but in some instances it is present in the liver, kidneys, etc.

Clinical Findings. The patient may give a history that he began to take the drug to relieve pain, insomnia, or worry, and that he has been unable to discontinue it. He may be able to do good work and to play games on a fixed daily dose such as 6 to 8 gr. (0.36 to 0.5 G.) of morphine. He gains no pleasurable sensations from the drug, and wishes to give it up, but is unable to do so. In some cases there is no indication that the individual is taking drugs; in others, tremors or other symptoms suggestive of drug addiction may be noticed. In more advanced cases the patient's friends can give more information. They will testify to a change in character and habits. The addict tends to be secretive, loses concentration and application, is irritable and depressed, except when under the influence of the drug. He becomes careless in his habits as

Pathology. Post-mortem, the liver, kidneys, spleen and lungs are congested, but there is no pathognomonic sign of cocaineism.

Clinical Findings. The victim derives a temporary sense of exhilaration followed by depression. As the habit is established the craving for the drug becomes irresistible. The addict is gradually unfitted for mental or physical work, loses his appetite, suffers from insomnia and his muscles are weak and tremulous. Hallucinations develop, and irritation of the skin giving rise to the sensation of creeping insects (cocaine bugs). This is felt chiefly on the palms. There may also be delusions of persecution. Sexual excitement is increased but sexual power is diminished.

On Examination: The pupils are usually dilated and the pulse frequent. The nostrils may be inflamed, and acne occur on the face near the nose.

Differential Diagnosis. The general appearance of the patient suggests that he is taking drugs, the nature of which can only be found by close observation.

Course and Complications. The habit is usually progressive; the patient may become insane.

Prognosis. The outlook is unfavourable. There is often recurrence after treatment, and death may be due to an overdosage or suicide by some other means.

Treatment. Prophylactic. The Dangerous Drug Acts restrict the sale of cocaine.

Curative. The patient should be sent to an institution for drug addicts where the treatment resembles that given for morphinism.

Acute Atropine, Belladonna and Hyoscyne Poisoning

Etiology. Poisoning usually occurs accidentally in adults, as from swallowing a chest liniment in mistake for a cough mixture in the dark. A belladonna plaster may cause poisoning in some individuals. Eye lotions containing atropine may cause acute poisoning, especially in children. Children may also eat the berries of the deadly nightshade.

Clinical Findings. The patient complains of burning and dryness of the mouth, dysphagia, nausea and diplopia.

On Examination: The patient may be found unconscious or in a state of excited delirium. The face is flushed and an erythematous rash may be present. The pupils are widely dilated and do not react to light. The pulse is frequent.

Treatment. If the poison has been taken by mouth the stomach should be thoroughly washed out with 2 gallons (9.0 litres) of warm water, or an emetic given and repeated in 2 hours, if necessary. For excited delirium phenobarbiton, sod. 100 mg. should be injected intravenously. A hypodermic injection of pilocarpine nitrate $\frac{1}{4}$ gr. (30 mg.) should be given. If there is respiratory failure artificial respiration and the inhalation of oxygen, or of oxygen and CO_2 should be given, as for CO poisoning. Further stimulants should be administered, such as the

Strychnine Poisoning

Etiology. Strychnine poisoning is rare. It may occur accidentally or be due to attempted murder.

Clinical Findings. The patient may notice a bitter taste on swallowing the fluid containing strychnine. Symptoms of poisoning rapidly ensue, muscular twitching passing into violent clonic and tonic convulsions. These may result in rupture of muscles or in opisthotonus, emprosthotonus or pleurosthotonus. The spasms pass off in a minute or so, and complete flaccidity ensues between successive fits. The pulse is feeble and frequent, and respiration may be interfered with, causing asphyxia. The mind remains perfectly clear and the dilated pupils and staring eyes express the torture of the individual. Death is not usually delayed in fatal cases for more than an hour or so, and may occur in a few minutes.

Treatment. Powerful sedatives should immediately be administered, such as a hypodermic injection of morphin. sulph. $\frac{1}{4}$ gr. (15 mg.), and the injection of thiopentone sodium, or anæsthetisation with chloroform. Thiopentone sodium should be given intravenously, 2 to 3 ml. of a 5% solution. When the patient is under the influence of thiopentone or chloroform the stomach should be washed out with 2 gallons (9.6 litres) of warm water. If there are signs of respiratory failure artificial respiration should be given together with inhalations of oxygen and 7% CO₂. When the effect of the thiopentone wears off a second dose can be given.

Acute Cocaine Poisoning

Etiology. Poisoning may occur accidentally as the result of an injection of a 10% solution of cocaine prepared for the anæsthetisation of a mucous membrane, or from swallowing cocaine from a nasopharyngeal plug. Suicidal poisoning, with death, may result from an adult swallowing 84 gr. (2 G.) of cocaine.

Clinical Findings. After taking a poisonous dose by mouth the patient notices dryness and burning in the mouth, buzzing in the ears, palpitations of the heart, hammering in the head and general trembling. There is headache, the vision becomes impaired, and cramps occur in the muscles. The patient dies in about an hour.

On Examination : The pupils are widely dilated and the patient is pale.

Treatment. The stomach should be washed out with 2 gallons (9.6 litres) of warm water containing pot. permang. 60 gr. (4 G.). Nikethamide (Coramine) 10 ml., should be injected intravenously for respiratory collapse.

Chronic Cocaine Poisoning

Etiology. The cocaine is usually taken as snuff, injected hypodermically, or chewed in the form of coca leaves. The drug is taken for its stimulating effect. Morphine and alcohol addicts may ultimately resort to it.

Meat Poisoning

Etiology. Meat poisoning is usually due to infection with organisms of the *Salmonella* group; these include the *Salmonella enteritidis*, *Bact. cholerae suis*, *Bact. aertrycke*, *S. typhi-murium* and *S. paratyphi B*. Less frequently staphylococci are the infecting organisms in canned meat. The meat may be infected by the hands of "carriers" of the organism or contaminated by the excreta of animals such as rats and mice. The meat is not usually altered in appearance or in smell, and toxins are not produced in the meat before ingestion. This is, however, not so in the case of botulinus infection. Mutton rarely causes meat poisoning, veal, pork and beef being the chief offenders. Staphylococci may grow in salted meats and produce enterotoxins. Improper preservation of canned meat as in typhoid and paratyphoid infections, and insufficient cooking or delay in consumption of meat are predisposing causes of poisoning. Children and debilitated adults are more prone to infection, and outbreaks usually occur in hot weather. Other diseases which may be conveyed by meat include infection with worms, tuberculosis, and rarely with anthrax. Poisoning has occurred from eating duck's eggs contaminated with *S. typhi-murium*, and since the use of dried eggs outbreaks of poisoning have occurred from infection with various *Salmonella* organisms, such as the *S. typhi-murium*, Newport, Montevideo, etc. To minimise risk of infection from dried eggs, the fluid mixture must be used immediately, to prevent the organisms multiplying.

Pathology. Post-mortem, hyperæmia may be seen in the mucous membrane of the small intestine, and to a lesser degree in the stomach.

Incubation Period. This is usually a matter of a few hours, but it may be prolonged to 2 or 3 days.

Clinical Findings. The onset is sudden, with shivering, nausea, vomiting and abdominal pain. If the offending food passes into the intestine, diarrhœa follows. The motions are at first loose and evil-smelling, and later they become watery and may contain mucus and blood.

On Examination: The tongue is furred, the temperature often raised to about 101° F. (38.3° C.) and an erythematous rash may appear. In severe cases the patient becomes collapsed and cramps occur in the legs. In some instances the causative organism can be recovered from the stools during the first few days, and a specific agglutination reaction is obtained with the patient's serum in the second week of the illness. The urine may show acetone bodies if there is prolonged vomiting. The vomit should be kept and examined for arsenic. A specimen of the food should be retained for bacteriological examination.

Differential Diagnosis. The nature of the illness is usually suggested by the fact that more than one person who has partaken of the same food is affected. Acute abdominal conditions, such as appendicitis, should be excluded.

Course and Complications. The illness passes off in a day or so in slight infections; in more severe cases the symptoms increase in

slow intravenous injection of 10 ml. of nikethamide (Coramine), and the rectal injection of 10 fl. oz. (300 ml.) of strong hot coffee.

Phenol and Coal Tar Disinfectants Poisoning

Etiology. These substances are available as a soapy emulsion, e.g., Lysol which contains 50% cresols, or as a plain solution, e.g., acid carbol. liq. Poisoning may occur accidentally from dressings applied to wounds, or from douches, by swallowing fluid from the wrong bottle or by inhalation. Carbolic acid may be swallowed in attempted suicide.

Pathology. There is local sloughing and necrosis, especially at the lower end of the œsophagus and in the stomach.

Clinical Findings. The patient notices an immediate burning sensation on swallowing, followed by anæsthesia. Unconsciousness rapidly follows a large dose.

On Examination: A white mark may be seen around the mouth due to the caustic effect of the poison, and the breath has a characteristic odour. If the patient is unconscious the breathing is stertorous and bubbling, with froth on the lips, which are congested and swollen. The face is cold and sweating. The pulse is frequent, and it may be weak and irregular. Vomiting is unusual. Râles may be heard scattered over the lungs. The urine may be dark (see carboluria p. 687) and contain protein.

Course and Complications. In mild cases the patient recovers consciousness, but appears dazed, and the voice may be hoarse owing to laryngitis. Complications include tracheitis, bronchitis, bronchopneumonia, lung abscess, suppression of urine, myocardial weakness, portal and peripheral venous thrombosis, and gastritis. Œsophageal and gastric perforation are rare. In severe cases death occurs in a few hours from respiratory and circulatory failure.

Treatment. The stomach should be washed out with great care, using a soft tube, with 2 gallons (9.6 litres) of warm water containing 2 oz. (60 G.) of sodium or magnesium sulphate. There should then be left in the stomach 2 fl. oz. (60 ml.) of this solution, together with 10 fl. oz. (300 ml.) of milk and the white of 1 egg. The bed should be warmed with an electric cradle, the foot of the bed raised 18 inches (45 cm.) on blocks, and the respiratory passage maintained. Nikethamide (Coramine) 10 ml., should be injected intravenously, and repeated frequently if there are signs of respiratory failure. Oxygen should be administered, as required, through a mask.

FOOD POISONING

Introductory. Ptomaine poisoning was the name formerly applied to poisoning by tainted food, especially tinned meat and fish. It was thought to be due to protein decomposition products produced by the action of micro-organisms. It is now believed that the majority of cases are due to infection with the micro-organisms themselves or their toxins, and rarely if ever to ptomaines.

Pathology. Post-mortem, hæmorrhages may be seen in the brain and spinal medulla (cord). The heart muscle is soft and the lungs may show bronchopneumonia. The toxin appears to paralyse motor nerve endings.

Incubation Period. This is only a matter of hours, as the toxin is present in the food.

Clinical Findings. The patient is taken ill after eating some contaminated substance, and usually several people are affected who have partaken of the same food. He feels ill with headache and usually complains of eye symptoms such as diplopia or blurring of the vision. The mouth is dry and there is dysphagia and often nasal regurgitation of liquids. The bowels are constipated, the legs and arms are weak, but there is usually no pain and the mind is quite clear. The voice may become very weak.

On Examination : The pupils are dilated, and do not react. Squint or nystagmus may be present and there is weakness of some of the external ocular muscles supplied by the third cranial nerve. There may be bilateral ptosis and paralysis of the palate. The tongue is furred and the temperature is usually subnormal. The pulse is slow at the onset but becomes more frequent later. There is flaccid paresis of the extremities and the deep reflexes are diminished. No sensory changes are present. The blood and cerebrospinal fluid are normal, and the causative organism is not usually found in the stools.

Differential Diagnosis. The symptoms of botulism are somewhat analogous to those of belladonna poisoning. If the infected food is given to chickens they develop paralyses. Other forms of food poisoning, such as those due to infection with bacteria of the salmonella group, must be excluded. In the latter the chief symptoms are gastro-intestinal. There are no muscular pareses, no visual disturbance, and the temperature is usually raised.

Course and Complications. The acute stage of the disease is usually short, lasting 3 or 4 days. Convalescence, however, is slow, and disturbances of vision may persist for several weeks.

Prognosis. The mortality rate is high, usually over 70%, and the shorter the incubation period the more likely is the disease to be fatal.

Treatment. Prophylactic. The bacilli and spores are killed by heat, such as 120° C., for 6 minutes. Foods, when being canned, should therefore be heated to an adequate temperature.

Curative. The patient should be kept in bed and the stomach immediately washed out with warm normal saline. A polyvalent botulinus antitoxin, if obtainable, should be given in doses of 50,000 units intramuscularly after sensitivity tests. If signs of respiratory failure occur, the patient should be placed in a respirator. An immediate injection of morphin. sulph. $\frac{1}{2}$ gr. (30 mg.) should be given, as this delays the action of the toxin.

Diseases Carried by Milk

Milk forms a good culture medium for micro-organisms, and impure

intensity for several days. A tendency to gastro-enteritis may persist subsequently.

Prognosis. The vast majority of cases recover completely.

Treatment. *Prophylactic.* Due care must be taken in canning food as regards the water in which the cans are washed, the purity of the contents, and the temperature to which they are exposed during the process. The cans must remain hermetically sealed. "Blown" tins should be rejected; the contents of a tin should all be eaten the day it is opened.

Curative. The patient should be in bed and kept warm. In the early stages the stomach should be emptied by an emetic of mustard $\frac{1}{2}$ oz. (15 G.) and warm water 10 fl. oz. (300 ml.), or the stomach washed out with warm normal saline solution. A dose of $\frac{1}{2}$ fl. oz. (15 ml.) of castor oil should then be given. If the diarrhoea persists after the bowels have been well opened an astringent mixture should be given such as Bism. carb. 10 gr. (0.6 G.), cret. 15 gr. (1 G.), tnc. catechu. 20 m. (1.2 ml.), aq. menth. pip. dest. ad. $\frac{1}{2}$ fl. oz. (15 ml.), $\frac{1}{2}$ fl. oz. (15 ml.) t.d.s. a.c. Tetracycline (Achromycin) is of value in certain salmonella infections, 50 mg./kg. body weight, in divided doses every 24 hours for 4 or 5 days.

If there is much abdominal pain, hot flannels or turpentine stupes should be applied, and tinct. opii 10 m. (0.6 ml.) can be added to the astringent mixture. Collapse is treated by stimulants such as hot coffee, 10 fl. oz. (300 ml.), per rectum. Acidosis and dehydration are best combated by rectal injections of 4 to 8 fl. oz., (120 to 240 ml.), of normal saline containing 5% dextrose every 4 to 6 hours. The patient should only take small quantities of boiled water or albumin water during the acute stages; later the diet is increased by adding dextrose 4 oz. (120 G.) in a pint (600 ml.) of water, and citrated milk, 2 gr. (0.125 G.) to 1 fl. oz. (30 ml.) diluted to half strength with water rusks, arrowroot, cornflour, jellies, custard, thin bread and butter, eggs and fish.

Botulism

Definition. An acute variety of food poisoning due to a specific bacillus.

Etiology. Botulism is caused by the *Clostridium botulinum* (*B. botulinus*), of which there are five types. Type A produces the most virulent toxin. The bacillus is a spore-forming anaerobic organism occurring in the intestines of animals and in soil. It produces an exotoxin acting on the nervous system. This toxin is present in the infected food. Any animal or vegetable food may be contaminated, but such articles as sausages, potted meat, ham, fish and canned meats and vegetables are most commonly affected. The Loch Maree outbreak in 1922 was due to sandwiches containing wild duck paste. The eight people who ate the sandwiches died. Type E Botulism has been reported due to fish caught in the Great Lakes in Canada and America. The hot-smoked fish were packed in plastic bags, and under these anaerobic conditions the spores developed. Often the fish were eaten without further cooking.

Fish Poisoning

Fish may be contaminated with the salmonella group of organisms. Oysters are liable to infection also with the enterica group. Mussels may cause poisonous symptoms owing to a toxin called mytilotoxin. *Diphyllobothrium latum* infestation may be caused by caviare, and by fish such as the pike, carp, etc.

Potato Poisoning

Sprouting potatoes may cause toxic symptoms. This may be due to a poison called solanin produced by the action of micro-organisms in the potato. There is headache, abdominal pain and gastro-enteritis.

Mushroom Poisoning

This is due to eating fungi which are mistaken for edible mushrooms. Death may occur in a day or so, after severe gastro-enteritis and hæmoglobinuric nephrosis. The *Amanita phalloides* (Death Cap) is responsible for more than 90% of deaths due to mushroom poisoning. The essential poison it contains is Amanita toxin. Anti-phalline serum should be given, if available, in doses of 40 ml. intramuscularly. In addition, mag. sulph. $\frac{1}{2}$ oz. (15 G.) should be given by mouth every hour until the bowels are opened, after washing out the stomach with 2 gallons (9.6 litres) of water or normal saline. For collapse symptoms an intravenous drip injection of normal saline containing 5% dextrose should be given, using 3 or 4 pints (1.8 to 2.4 litres). To control pain and restlessness atropin. sulph. $\frac{1}{100}$ gr. (0.6 mg.) and morphin. sulph. $\frac{1}{4}$ gr. (15 mg.) should be injected subcutaneously.

Cheese Poisoning

Infection with the salmonella group may occur; in some instances a toxin, tyro-toxicon, may develop in cheese.

Rye Poisoning

The fungus *claviceps purpurea* may occur on rye or grains, causing ergotism. Gangrene of the extremities or nervous lesions may develop.

Lathyrism

Vetch seeds, if used as a substitute for wheat, may cause symptoms of poisoning. There is spastic paralysis of the legs with lumbar pain.

Food Idiosyncrasies

Certain individuals are sensitive to special articles of food. Thus allergic symptoms may result from eating fish, eggs, milk, etc. An urticarial rash, nausea, vomiting, dyspnoea and collapse are the most prominent symptoms.

milk may cause much sickness. The diseases conveyed by milk include:

Tuberculosis. Infection comes from the cows, more rarely from human sources.

Diarrhœa. This is usually due to organisms such as Gaertner's bacillus and streptococci.

Tonsillitis. Streptococcal infection in milk may cause an epidemic of acute tonsillitis.

Enterica Group Infections. Milk is usually contaminated by the hands of a "carrier" or by infected water used for washing the cans or diluting the milk.

Cholera and Dysentery. The organisms usually gain access to the milk through infected water.

Scarlet Fever. Milk is probably infected from contact with milkers who have suffered from a mild unrecognised attack of scarlet fever, or who are carriers of the disease.

Diphtheria. Infection here is usually from carriers of the disease.

Malta Fever and Abortus Fever. This is conveyed by goat's and cow's milk.

Foot and Mouth Disease. Men may be affected by milk of cows suffering from the disease.

Milk Sickness. This is a disease which may affect man owing to consumption of the milk of cows suffering from "the trembles."

Q Fever. This is described on p. 593.

Penicillin Reaction. This may be due to the cow being given injections of penicillin for mastitis, the milk being subsequently drunk by a person sensitive to penicillin.

Aflatoxin. This is produced by *Aspergillus flavus* which attacks ground nuts. Milk of cows fed on infected ground-nut meal may contain a small amount of a toxic metabolite of aflatoxin B. In infected cows hepatic necrosis has been observed, which may possibly lead to cancer.

The characteristics of a milk epidemic: The onset is usually fairly definite and limited to a group of houses or a district supplied from one source. The occupants of houses in which the milk is boiled are usually spared. When scarlet fever or diphtheria is due to milk the symptoms are usually slight.

Treatment. Prophylactic. The purity of the milk supply should be guaranteed by Public Health measures. This involves inspection of cows and cowsheds, attested herds, cleanliness in milking, pasteurisation, rapid distribution and the use of sealed bottles. In very hot weather milk should be boiled directly it is received in the house, and all milk given to infants, unless adequately pasteurised, should be brought to the boil to lessen the risk of infection with tuberculosis.

Curative. This is considered in the sections dealing with the various diseases.

Staphylococcal Poisoning

In addition to infecting salted meats staphylococci may produce enterotoxins in milk, cheese, custard, pastries, ice cream, liver sausage, potato salad, etc.

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